



**AFRL-PR-WP-TR-2007-2112**

**PROPULSION AND POWER RAPID RESPONSE  
RESEARCH AND DEVELOPMENT SUPPORT**

**Delivery Order 0042: Demonstration and Evaluation of Fischer-Tropsch Research Fuels for the DoD Assured Fuels Program**

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Universal Technology Corporation**

**DECEMBER 2006  
Final Report**

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**AIR FORCE RESEARCH LABORATORY  
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UNITED STATES AIR FORCE**

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## FOREWORD

Continued dependence on imported oil has the very real potential to negatively impact future roles and missions of the Department of Defense (DoD). In response, the military, under the Single Fuel for the Battlefield concept has begun to focus on the use of alternative JP-8 like jet fuels for use in all ground tactical vehicles and military aircraft. Demonstration, qualification and certification of new fuels are complex as it requires review and proof-of-concept testing by system developers and component manufacturers to assure fit-for-purpose. Experimental alternative jet fuels were needed to continue the prerequisite research and demonstrations.

Syntroleum Corporation located in Tulsa, Oklahoma currently operates the only fully integrated domestic Fischer-Tropsch (FT) plant. The plant was constructed in cooperation with the Department of Energy (DOE) via funding provided by the Department's Ultra-Clean Fuels Program. As part of this DOE program and subsequent contracts with (DoD), Syntroleum has produced FT research product for the Air Force, Army, and Navy for initial evaluations. These initial evaluations by the DoD have shown the hydrocarbon product produced via the Syntroleum Fischer-Tropsch process to have superior performance characteristics, (i.e., increased level of thermal stability, reduction of copper migration in shipboard applications,<sup>1</sup> reduction in particulate matter emissions, and reduction of combustor liner temperatures), compared to that of fuels produced by conventional crude oil processing (refining).

This report describes the product produced by the Syntroleum Corporation, Tulsa, Oklahoma, under subcontract to the Universal Technology Corporation, Beavercreek, Ohio. The material is part of research sponsored by the Air Force Research Laboratory under contract F33615-02-D-2299. This report details the manufacture, laboratory testing, suitability evaluation, trend analyses and deliveries of Fischer-Tropsch (FT) research aviation fuels<sup>2</sup> to the Department of Defense for both laboratory investigation and full-scale demonstrations.

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<sup>1</sup> ACS Pre-print #776159, 2004 - Evaluation of Fischer-Tropsch Synthetic Fuels For United States Naval Applications - Philip H. Chang, John E. Colbert, Dennis R. Hardy and Joseph T. Leonard

<sup>2</sup> The terms Fischer-Tropsch Research Fuel, FT Research Fuel, Fischer-Tropsch Research Fluid, (FTRF) and FT fuel are used interchangeably throughout this report.

## **ACKNOWLEDGMENTS**

The authors would like to acknowledge the support of several persons and organizations that made it possible to obtain the data described in this report:

The Syntroleum Corporation, Mr. John Dolan and all of their personnel, for excellent product support and subcontract performance and execution.

Personnel of the Air Force Petroleum Office, Detachment 3, WR-ALC/AFTLA, Wright-Patterson AFB, Ohio, who conducted the fuel sample analyses of shipment samples.

The Patuxent River contamination investigation team (Mr. John Buffin and Mr. Chas Emberger, NAVAIR AIR 4.4.5, Mr Tim Mudry, AFPET, Mr. Robert Morris Jr. (AFRL/PRTG), Mr. Mike Young (DESC), Mr. Todd Warren and Mr. Bill McCuddy (UTC).

Dr. Matthew J. DeWitt, University of Dayton Research Institute (UDRI), for the volumetric heating value calculations, and Mrs. Linda M. Shafer and Mr. Richard C Striebich, University of Dayton Research Institute (UDRI), for compilation and analysis of data.

## SUMMARY

The Syntroleum Corporation produced and delivered 104,278 gallons of Fischer-Tropsch research fluid (FTRF) to the DoD from July 18, 2006 to September 21, 2006. The FT Research Fluid was produced by Syntroleum Corporation at their gas-to-liquid plant located at 880 W. Tenkiller Road, Port of Catoosa, OK 74015 using pre-existing wax from their typical natural gas feedstock.

Antioxidant (AO), Corrosion Inhibitor/Lubricity Improver (CI/LI), and Fuel Electrical Conductivity (SDA) additives were successfully incorporated into the finished FT product and a very consistent product was produced. Production samples were analyzed by Syntroleum for product acceptance and results reported via Certificate of Analysis, (CofA). In addition, supplemental analyses were accomplished by Syntroleum using outside laboratories to complete “as manufactured” baselines. Samples were also taken from each truck shipment and analyzed by the Air Force Petroleum Office to provide “as shipped” baselines. These “as manufactured” baselines and “as shipped” baselines compare extremely well and fully characterize the Fischer-Tropsch (FT) research aviation fuels supplied to the Department of Defense under this effort. Trends analysis shows a very consistent product with average density .7548 kg/L.

One shipment (to the Navy at Paxtuxent River, MD) became contaminated at off-load. An investigation concluded that the most likely source of this contamination was the cast iron pump located on the delivery truck used to transport the fuel. It is recommended that, in the future, delivery trucks utilize pumps made from stainless steel or corrosion resistant materials, (no cast iron pumps).

This effort was accomplished under Contract F33615-02-D-2299, Delivery Order 42 (Jet Fuel Research & Demonstration) for the Air Force Research Laboratory. Mrs. Michele Puterbaugh (Contractor, Universal Technology Corporation) was the project manager for this effort and Mr. James Klein (Contractor, Universal Technology Corporation) was the technical lead.

**Table 0-1. FT Fuel Deliveries**

<b>Delivery Quantity</b>	<b>Delivery Location</b>	<b>Delivery Dates</b>	<b>Comments</b>
29,215 gals	Tinker AFB	July 10 to July 14, 2006	5 truckloads
6,800 gals	SWRI	July 24	1 truckload
38,723 gals	EAFB	July 25 to August 30	6 truckloads
10,000 gals	Patuxent River	August 11 to September 12	2 truckloads
2,300 gals	Selfridge ANGB	August 17	1 truckload
17,053 gals	WPAFB	August 11 to September 21	4 truckloads
187 gals	AFPET		
Total 104,278 gals			



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## **1.0 INTRODUCTION**

The objective of this project was to produce, analyze and deliver Fischer-Tropsch research fuel to a draft specification in the quantities required for direct support of high priority DoD assured fuels research and demonstration plans and schedules. To achieve this objective a comprehensive Research Project/Shipping/Quality Plan was prepared and executed. This plan is summarized in Appendix B. An investigation report of contamination at Patuxent River MD is provided as Appendix C. The final Syntroleum Corporation technical report is provided as Appendix D. This Syntroleum report provides a summary of their production and delivery processes, exactly what and how additives were included and controlled, and all of their Certificate of Analysis ( $C_{ofA}$ ) “as manufactured” sheets for all of the shipments. These ( $C_{ofA}$ ) sheets were then analyzed for trends and property variation. Air Force test results of “as shipped” product are provided in Appendix E and a comparison to the Syntroleum analyses is discussed.

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## **2.0 DESCRIPTION OF FT RESEARCH FUEL**

### **2.1 Additive Research**

During contract negotiations, an issue regarding electrostatic buildup surfaced as a safety issue. With a conductivity of zero, there is an increased risk of static discharge and a catastrophic occurrence during transferring the fuel at the point of manufacture, upon loading, and upon off-loading and receipt. Additizing at Syntroleum was determined to minimize this risk and the draft specification was revised to require conductivity additive.

Subsequent to the initial subcontract, the Government requested UTC contact Syntroleum regarding the addition of a Corrosion Inhibitor / Lubricity Improver (CI/LI) to the FT Research Fuel. Syntroleum received a modification to the subcontract on June 26, 2006 specific to the request for the addition of the CI/LI.

### **2.2 Conductivity issues**

During the course of the effort, two issues surfaced with regard to the addition of conductivity additive. Initially, Syntroleum performed the conductivity test at ambient room temperature and the first iso container analysis showed a conductivity of 334 pS/m at 68.8°F. Concern was raised that this might exceed the maximum limit at a test temperature of 85°F. The test temperature is NOT in the ASTM D2624 standards; the temperature reference is part of MIL-DTL-83133E Table 2.3-2 (Footnote 11). The test was then rerun at 85°F and showed an acceptable conductivity of 414 pS/m. The procurement specification was then revised to include a test temperature of 85°F.

The second issue was the acceptance of an iso batch<sup>3</sup> of FT fuel with a high conductivity, (1064 pS/m at 85°F). Syntroleum was planning on using this as a blendstock with “new” production in order to meet the specification range of 150 – 450 pS/m; however the Government was interested in a quick delivery to support immediate engine test cell schedules and accepted this iso batch with the high conductivity considering it was to be blended and the planned test was not in a flying aircraft. Further guidance was also suggested by the Government to adjust the conductivity additive additization rate downward from 3.0 mg/L to 1.5 mg/L. It was believed that this would get conductivity down to a mid-range level, leaving room for varying conductivity due to blending and blending stock CU levels.

### **2.3 Final Specification**

The final specification used for manufacture and acceptance of FT fuel is shown below.

**Table 2.3-1. FT Research Fluid Specification**

<b>1.0 REQUIREMENTS</b>
<b>1.1 Materials</b> The FT Research Fluid supplied per this document shall be hydrocarbons derived from Fischer-Tropsch synthetic crude and containing additives in accordance with 1.3.
<b>1.2 Chemical and Physical Requirements</b> The chemical and physical requirements of the finished FT Research Fluid, at point of manufacture, shall conform to those listed on this page and in Table 2.3-2.

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<sup>3</sup> Research fluid is produced and stored in a nominal 6,000 gallon standard (iso) container prior to shipment.

**Table 2.3-1. FT Research Fluid Specification (Cont'd)**

<p><b>1.3 Additives</b>  Antioxidant (AO), Corrosion Inhibitor/Lubricity Improver (CI/LI), and Fuel Electrical Conductivity (SDA) additives shall be required for this FT Research Fluid. Antioxidant additive shall be used in accordance with Paragraph 1.3.1 below. Electrical Conductivity additive shall be used in accordance with Paragraph 1.3.2 below. Corrosion Inhibitor/Lubricity Improver (CI/LI) additive shall be used in accordance with Paragraph 1.3.3 below. Fuel System Icing Inhibitor (FSII) shall not be added to this FT Research Fluid.</p>
<p><b>1.3.1 Antioxidants</b>  Immediately after processing and before FT Research Fluid is exposed to the atmosphere, an approved antioxidant (see 1.3.1.1) shall be added to prevent formation of peroxides after manufacture. The concentration of antioxidant to be added shall be not less than 17.2 mg nor more than 24.0 mg of active ingredient per liter of FT Research Product (6.8 to 8.4 lb/1000 barrels).</p>
<p><b>1.3.1.1 Antioxidant Formulations</b>  The following antioxidant formulations are approved:</p> <ol style="list-style-type: none"> <li>2,6-di-tert-butyl-4-methylphenol</li> <li>6-tert-butyl-2,4-dimethylphenol</li> <li>2,6-di-tert-butylphenol</li> <li>75 percent min 2,6-di-tert-butylphenol and 25 percent max tert-butylphenols and tri-tert-butylphenols</li> <li>72 percent min 6-tert-butyl-2,4-dimethylphenol and 28 percent max tert-butyl-methylphenols and tert-butyl-dimethylphenols</li> <li>55 percent min 2,4-dimethyl-6-tert-butylphenol and 15 percent min 2,6-di-tert-butyl-4-methylphenol and 30 percent max mixed methyl and dimethyl tert-butylphenols</li> </ol>
<p><b>1.3.2 Conductivity Additive</b>  Fuel Electrical Conductivity additive shall be added to the FT Research Fluid in conjunction with an approved Antioxidant additive as defined in Section 1.3.1.1. To improve the safety and handling of the FT Research Fluid during storage and transfer operations, the fuel electrical conductivity shall be maintained at between 150 and 450 pS/m as per MIL-DTL-83133E Table 2.3-2 (Footnote 11). Fuel Electrical Conductivity shall be maintained by the addition of Stadis 450 (Manufacturer: Octel America, Inc., Newark, DE 19702). ASTM D1655 (Standard Specifications for Turbine Fuels, Section 5.2.3.1) which stipulates up to 3.0 mg/L of Stadis 450 can be added to jet fuel shall be followed. Conductivity shall be measured according to ASTM D2624 and reported on each Certificate of Analysis.</p>
<p><b>1.3.3 Corrosion Inhibitor/Lubricity Improver Additive (CI/LI)</b>  A Corrosion Inhibitor/Lubricity Improver additive shall be blended into the FT Research Fluid at the point of manufacture. The amount of CI/LI added to the FT Research Fluid shall be between the values of 13 grams of CI/LI additive per cubic meter of FT Research Fluid and 17 grams of CI/LI additive per cubic meter of FT Research Fluid – with a target value of 15 grams CI/LI additive per cubic meter of FT Research Fluid.</p>
<p><b>1.3.3.1 Corrosion Inhibitor/Lubricity Improver (CI/LI) Additive – GFP</b>  The Corrosion Inhibitor/Lubricity Improver additive shall be provided by the Government as GFP<sup>4</sup> in a quantity sufficient to additize all of the FT Research Fluid obtained under this task order in accordance with the latest revision of QPL-25017.</p>
<p><b>1.4 Workmanship</b>  At the time of Government acceptance, the finished FT Research Fluid shall be visually free from undissolved water, sediment, or suspended matter and shall be clear and bright. In case of dispute, the FT Research Fluid shall be clear and bright at 21°C (70°F) and shall contain no more than 1.0 mg/L of particulate matter as indicated in Table 2.3-2, “Chemical and Physical Requirements and Test Methods.”</p>

<sup>4</sup> The AFPET supplied Octel DCI-4A to Syntroleum as the CI/LI.

**Table 2.3-2. Chemical and Physical Requirements and Test Methods**

Specification Properties of FT Research Product			
Physical Properties	Test Method	Units	Specification Value
Density	ASTM D-4052	kg/L	0.75 - 0.77
API Gravity	ASTM D-4052	°	51.6 - 56.5
Ash, max	ASTM D-482	wt%	0.001
Flash Point, min	ASTM D-93	°C	38
Freeze Point, max	ASTM D-5972	°C	-47
Color	ASTM D-156	Saybolt	Report
Paticulates, max	ASTM D-2276 or ASTM D-5452	mg/L	1.0
Kinematic Viscosity, max @ -20°C	ASTM D-445	cSt	<8.0
Kinematic Viscosity, , @ 40°C	ASTM D-445	cSt	1.3 - 1.9
Distillation, % recovered	ASTM D-86 (D2887)	°C	
<i>IBP</i>		°C	Report
<i>10% Recovered, max</i>		°C	205 (186)
<i>20% Recovered</i>		°C	Report
<i>50% Recovered</i>		°C	Report
<i>90% Recovered</i>		°C	Report
<i>FBP, max</i>		°C	300 (330)
Copper Strip Corrosion, 2 hr at 100°C	ASTM D-130		No. 1
Aromatic Carbon, max	ASTM D-5292	Mol %	< 0.5
Sulfur, Total, Max	ASTM D-5453	ppm	1
Cetane Index	ASTM D-976		Report
Net Heat of Combustion, min	ASTM D-4809	MJ/kg (btu/lb)	>42.8 (18397)
Hydrogen Content, min	ASTM D-3701 or D-3343	Mass %	>15
Smoke Point, min	ASTM D-1322	mm	>40
Conductivity @ 85°F	ASTM D-2624	pS/m	150 - 450

## 2.4 Contamination Issue

As part of this program, the Air Force agreed to ship 10,000 gallons of the FT fuel to NAVAIR at Paxtuxent River, MD for filter/coalescer testing. To accommodate receipt of this fuel, NAVAIR set aside two 5,000-gallon tanks. During the first shipment of 6,100 gallons of FT fuel to NAVAIR, 4,600 gallons were offloaded to one tank. As hoses were disconnected for reconnection to the second tank, the small amount of fuel weeping from the hose end and from the truck pump was observed to be contaminated with solid material and had a honey color. Samples of this fuel were taken for analysis and receipt was terminated leaving 1,500 gallons of FT fuel remaining in the delivery truck (see picture below showing contaminated and uncontaminated sample). NAVAIR rejected the remaining 1,500 gallons of fuel and this fuel was routed to Wright-Patterson Air Force Base for evaluation. An immediate investigation was accomplished by a team of experts from AFRL, AFPET, DESC, UTC, and NAVAIR. The initial laboratory check indicated that the sediment was predominantly “ferro magnetic”.



**Figure 2.4-1. Patuxent River Contaminated Sample**

From visual analysis and inspection of the debris and the truck pump and hose hardware, the team consensus was that the most likely source of the contamination was the truck pump used to off-load the fuel. The team did not believe the hoses were involved in the contamination. On-truck driver records indicated that the pump was last cleaned on 4 Aug and was not used until the defuel operation on the 14<sup>th</sup>. With temperatures in the 80's and 90's in the region during this time period, along with the pump being made of cast iron, a significant amount of corrosion could've resulted inside the pump between Aug 4<sup>th</sup> and Aug 14<sup>th</sup>. This is the most likely source of some of the debris. Upon completion of investigation and after final analysis, NAVAIR agreed to accept the 4,600 gallons of fuel delivered to them and the remainder of the 10,000 gallon requirement was eventually fulfilled.<sup>5, 6, 7</sup>

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<sup>5</sup> NAVAIR AIR 4.4.5, e-mail, John Buffin Jr., Sept. 11, 2006.

<sup>6</sup> AFPET analysis report, POSF 5018, attached Appendix E.

<sup>7</sup> Syntroleum analysis, test date 30 August 2006, attached Appendix D.

### 3.0 TREND ANALYSIS

#### 3.1 Analysis of FY 2006 Product

Variation of key chemical and physical properties with time is provided in the following charts based on ( $C_{ofA}$ ) data and shipment date. A very consistent product was delivered.

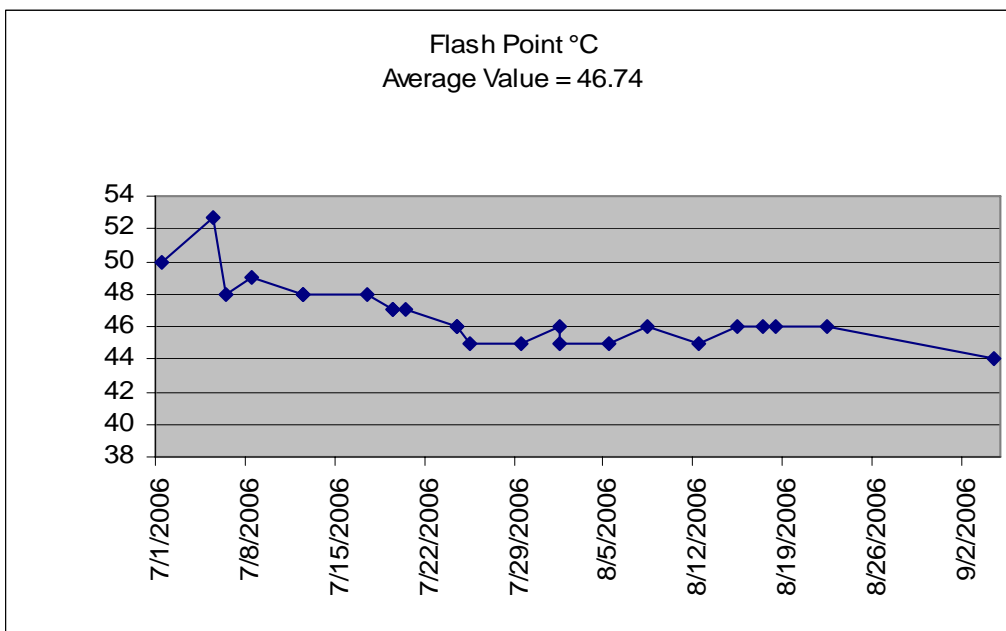


Figure 3.1-1. Flash Point Trend

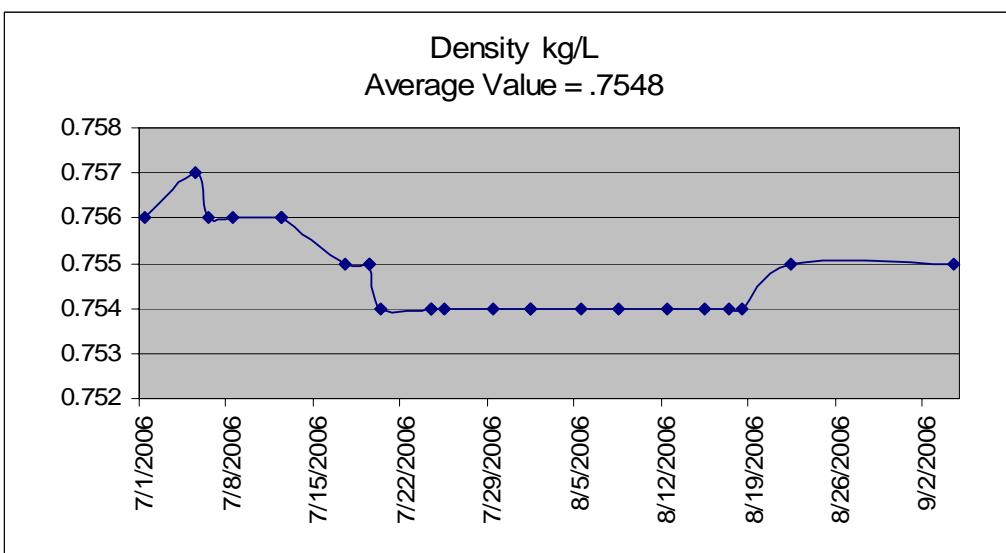
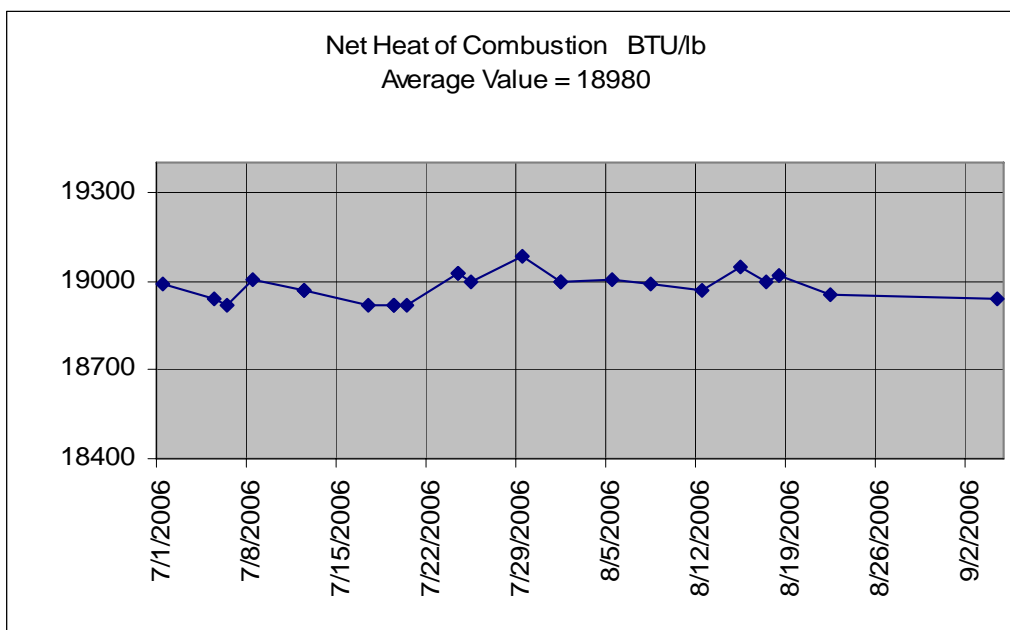
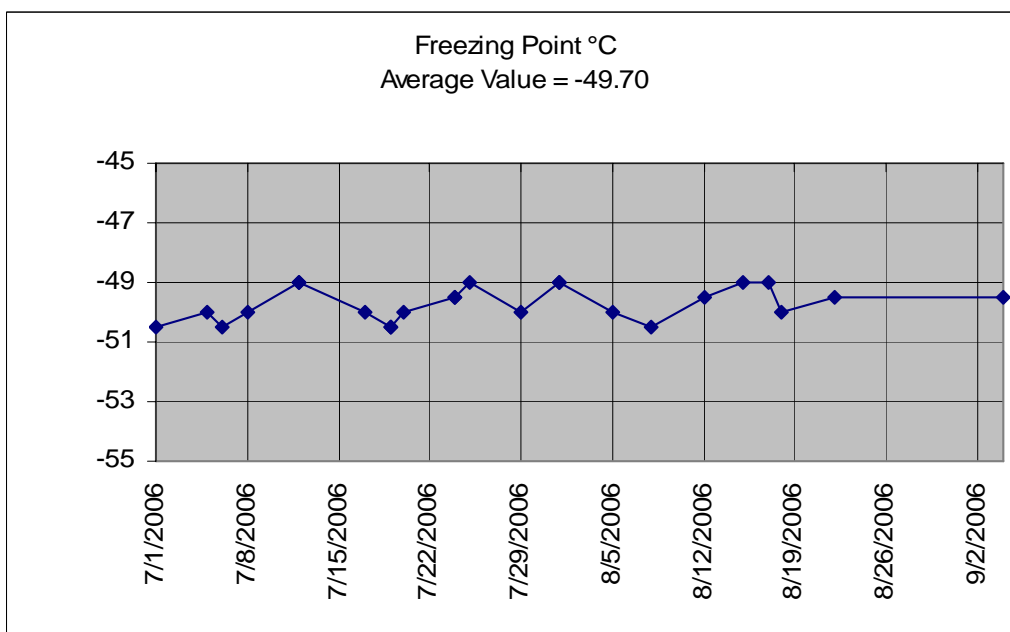


Figure 3.1-2. Density Trend

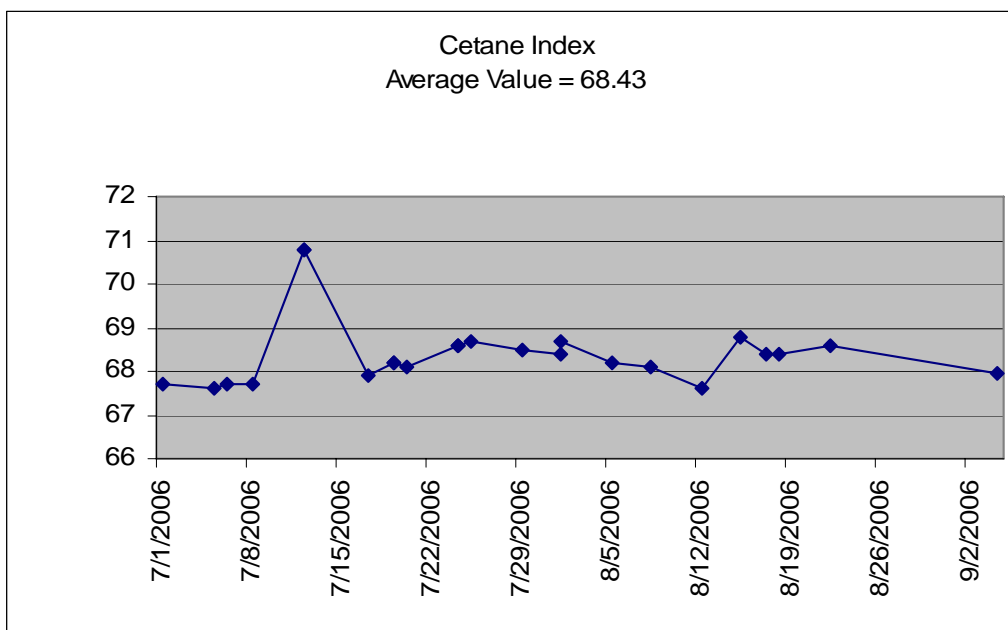




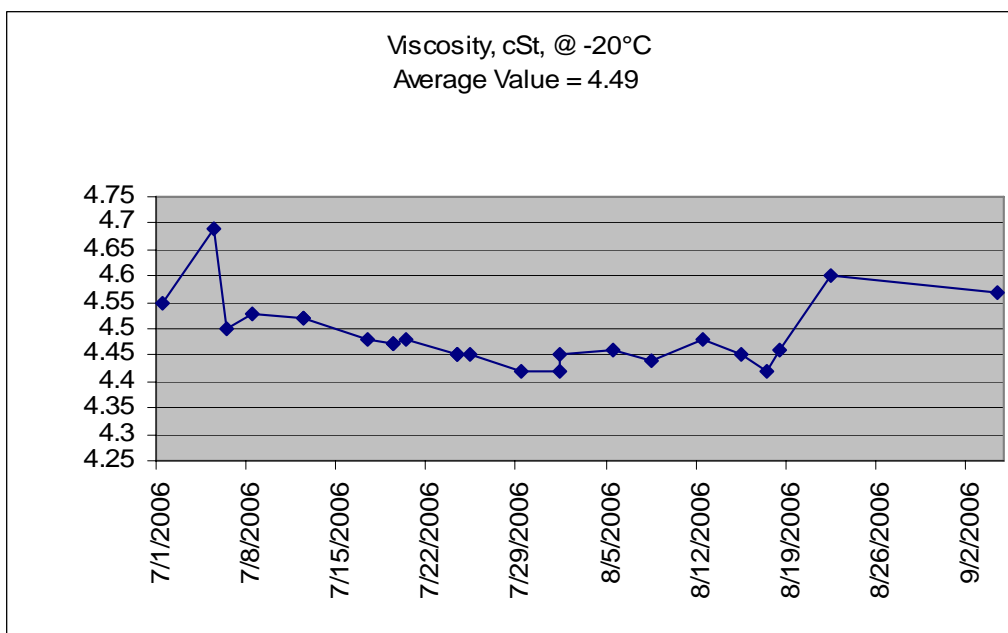
**Figure 3.1-3. Net Heat of Combustion Trend**



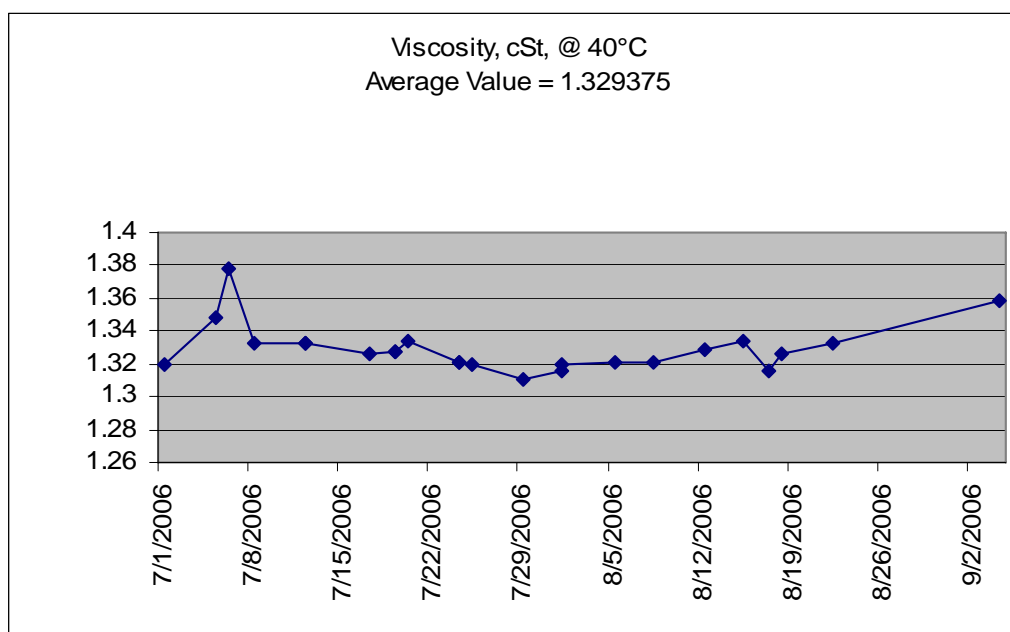
**Figure 3.1-4. Freezing Point Trend**



**Figure 3.1-5. Cetane Index Trend**



**Figure 3.1-6. Viscosity @ -20°C Trend**



**Figure 3.1-7. Viscosity @ +40°C Trend**

### 3.2 Comparison of FY2006 Production to Earlier (FY2004 & FY2005) Production

**Table 3.2-1. Production Comparisons**

Production Batch	Relative Density kg/L @ 15°C	Flash Point °C	Freezing Point °C	Heat of Combustion BTU/lb
POSF 4709 (07/22/04)	.7587	48	-48	18970
POSF 4734 (10/01/04)	.7575	49	-59	18965
POSF 4820 (10/01/05)	.7559	45	-51	18976
FY2006 Average	.7548	46.77	-49.7	18978
JP-8 Specification (for reference)	.8397 to .7753	38 min	-47 max	18400 min

### 3.3 Viscosity Extrapolation

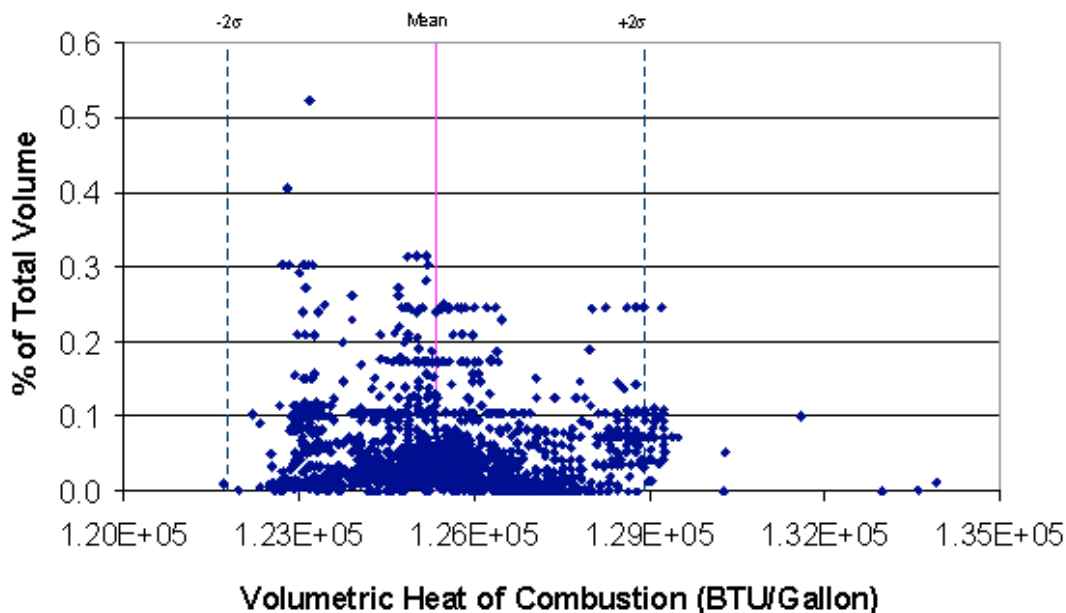
The specification provided by the Government does not require a viscosity test at -40°C. However, this property is of interest. Average kinematic viscosities as reported by the Syntroleum (C<sub>of</sub>As) were extrapolated to -40°C using the ASTM 341-93 chart method. This extrapolation shows a value of 9 cSt at -40°C. In comparison, the AFPET performed testing per ASTM D445 on the “as shipped” samples. This testing shows an average value of 9.71 cSt, with a minimum value of 9.2 cSt and a maximum value of 10.4 cSt.

### 3.4 Volumetric Heating Value

Calculations were made for both the average and minimum volumetric heating values as follows:

- FY 2006 FT Average:  $(18980 \text{ BTU/lb}) (0.7548 \text{ g/cc}) (3785 \text{ cc/gal}) (\text{lb}/453.6 \text{ g}) = 119,542 \text{ BTU/gal}$
- FY 2006 FT Minimum:  $(18917 \text{ BTU/lb}) (0.754 \text{ g/cc}) (3785 \text{ cc/gal}) (\text{lb}/453.6 \text{ g}) = 119,019 \text{ BTU/gal}$

Preliminary analysis was performed by the University of Dayton Research Institute, (UDRI), using the DESC PQIS 2004 Fuels Data to provide a basis of comparison of the FT fuel to actual JP-8 property data. The calculated Volumetric Heating Value for each JP-8 fuel shipment procured by DESC in 2004 is shown in Figure 3.4-1. Although the distribution is relatively flat, the mean value for JP-8 was approximately 125,350 BTU/gallon with a 95% confidence interval of  $\pm 3,580$ . Based on the mean values, the FY 2006 FT fuel had approximately a 4.7% lower overall Volumetric Heating Value than JP-8. However, it should be noted that due to the “flat” JP-8 distribution, further analysis is required to fully understand possible implications of this property on mission application and capability.



**Figure 3.4-1. Volumetric Heating Value for JP-8 Fuel (DESC PQIS 2004 Data)**

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## 4.0 DATA ANALYSIS

### 4.1 Data Matrix

A data correlation matrix is provided in Table 4.1-1, and a typical comparison to the independent government analyses performed by the AFPET is shown in Table 4.1-2.

**Table 4.1-1. Data Correlation Matrix**

Delivery Location	Shipment	Syntroleum CA (Iso container #)	AFPET (POSF #)
TAFB	1	124166-7	4971
	2	124239-1	4972
	3	124146-1	4969
	4	124169-3B	4970
	5	124136-9	4968
SWRI	1	124248-9 & 124146-1B	4991
EAFB	1	124146-1B & 124169-3	4988
	2	124136-9B & 124169-3B	4989
	3	124166-7B, 124146-1C, & 124136-9B	4990
	4	124136-9C	4997
	5	124261-6	5002
	6	124169-3C	5001
Patuxent River	1	124248-9C	4993
	2	124239-1B & 124146-1C	5035/5018
Selfridge	1	124146-1C	4998
WPAFB	1	124248-9D	5018
	2	124166-7C	5032
	3	124248-9C	5034
	4	124013-0 & 124239-1B	5033

**Table 4.1-2. Typical Comparison of “As Manufactured” FT to “As Shipped” FT**

Physical Properties	Units	“As Manufactured” (ISO 124261-6)	“As Shipped” POSF 5002
Density @15°C	kg/L	.754	
API Gravity	Degree	55.9	55.9
Ash, max	wt %	<0.001	
Flash Point, min	°C	45	50
Freezing Point, max	°C	-49.5	-50
Color	Saybolt	+30	
Paticulates	mg/L	.2	.4
Viscosity, @ -20°C	cSt	4.48	4.6
Viscosity, @ 40°C	cSt	1.329	
Distillation, % recovered	°C	ASTM D2887	ASTM D86
<i>IBP</i>	°C	115	152
<i>10% Recovered, max</i>	°C	149	173
<i>20% Recovered</i>	°C	167	181

**Table 4.1-2. Typical Comparison of “As Manufactured” FT to “As Shipped” FT (*Cont’d*)**

<b>Physical Properties</b>	<b>Units</b>	<b>“As Manufactured” (ISO 124261-6)</b>	<b>“As Shipped” POSF 5002</b>
<i>50% Recovered</i>	°C	210	209
<i>90% Recovered</i>	°C	265	247
<i>FBP, max</i>	°C	287	259
Copper Strip Corrosion,		1a	1a
Aromatic Carbon, max	Mol %	<0.1	0
Sulfur, Total, Max	ppm	.6	>2
Cetane Index		67.6	68
Net Heat of Combustion, min	BTU/lb	18971	18910 D4809 test result
Hydrogen Content, min	Mass %	15.55	15.4
Smoke Point, min	Mm	>40	>40
Conductivity	pS/m	387	300

## **5.0 CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 Conclusions**

- a. A Fischer-Tropsch research fuel was successfully produced by the Syntroleum Corporation to a draft specification and 104,278 gallons were delivered to the DoD Assured Fuels research program.
- b. The Syntroleum Corporation successfully additized the final FT Research Fuel with Antioxidant (AO), Corrosion Inhibitor/Lubricity Improver (CI/LI), and Fuel Electrical Conductivity (SDA) additives.
- c. Trend analyses shows that a very consistent product was produced and shipped.

### **5.2 Recommendations**

- a. To minimize contamination, delivery trucks should not use cast iron pumps; pumps made from stainless steel or corrosion resistant materials should be utilized.



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## **APPENDIX A – Acronym and Abbreviations Dictionary**

AFB	Air Force Base
AFPET	Air Force Petroleum Office
AFRL	Air Force Research Laboratory
ANGB	Air National Guard Base
AO	Antioxidant
API	American Petroleum Institute
ASTM	American Society for Testing and Materials Standards
BTU	British Thermal Unit
C	Celsius
CI/LI	Corrosion Inhibitor/Lubricity Improver
CofA	Certificate of Analysis
cSt	centistokes
CU	Conductivity Units
deg	Degrees
DESC	Defense Energy Support Center
DoD	Department of Defense
DOE	Department of Energy
EAFB	Edwards Air Force Base
FBP	Final Boiling Point
FSII	Fuel System Icing Inhibitor
FT	Fischer-Tropsch
ISO	International Organization for Standards
PAX	Patuxent
POSF	Fuels Designator
PRTG	Fuels Branch (Turbine Engine Division, Propulsion Directorate, AFRL)
PQIS	Petroleum Quality Information System
SDA	Static Dissipater Additive
SwRI	Southwest Research Institute
TAFB	Tinker Air Force Base
WPAFB	Wright-Patterson Air Force Base
UDRI	University of Dayton Research Institute
UTC	Universal Technology Corporation

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## **APPENDIX B --Execution Plan Summary**

Syntroleum Corporation, under subcontract 06-S530-0042-02-C1 to UTC, shall produce 100,000 gallons of Fischer Tropsch Research Fuel (“FT Research Fuel”) meeting the specifications provided and arrange for shipping by truck to the locations designated.

The initial subcontract was executed on June 7, 2006 between Syntroleum and UTC. Subsequent to the initial subcontract, the Government requested that a corrosion inhibitor/lubricity improver (CI/LI) be added to the FT Research Fuel during manufacture. The CI/LI additive was to be furnished as Government Furnished Material.

### **FT Research Fuel Production**

Syntroleum shall produce the FT Research Fuel at its gas-to-liquids demonstration facility located near Tulsa, Oklahoma. The feedstock for the FT Research Fuel will be natural gas. The estimated daily production of on-spec material is 1,500 gallons per day, resulting in an estimated 69 days of production. The plant is scheduled to start producing on-specification material on or about June 26<sup>th</sup>, 2006.

Production of the FT Research Fuel will be into self-contained 6,000 gallon ISO containers.

### **Quality Assurance**

The Syntroleum plant will produce the FT Research Fuel into self-contained ISO containers which hold a nominal 6,000 gallons. Prior to production, each ISO container is cleaned only if the ISO container has stored a material other than Fischer Tropsch product. Appropriate levels of additives for antioxidant, conductivity, and corrosion inhibitor / lubricity improver are added during the production / handling process to ensure the specifications are met.

During production, an 8oz sample is taken during each operating shift (3 times daily) to check the quality of the FT Research Fuel prior to the Certificate of Analysis (C<sub>ofA</sub>). The samples are sent to Syntroleum lab and tested for the following qualities:

- Density at 15 °C
- Flash Point
- Freezing Point
- Distillation (D2287)
- Viscosity at 40 °C

The lab will transmit the results to plant operations to ensure the ISO container is on specification at the end of the production into the specific ISO container. Upon completion of production into a specific ISO container, a sample of the ISO container will be taken and sent to the Syntroleum lab for analysis. The results will be identified on a (C<sub>ofA</sub>) for that specific ISO container. Each ISO container will have a specific number and production date associated with it. The Syntroleum lab will complete the following analytical tests for the creation of the (C<sub>ofA</sub>):

**Table B-1. Syntroleum Analytical Tests for Certificate of Analysis**

Density at 15 °C per ASTM D4052
API @ 60 °F per ASTM D4052
Ash per ASTM D482
Flash Point per ASTM D93
Freezing Point per ASTM D5972
Color per ASTM D156
Viscosity @ 40 °C per ASTM D445
Distillation (ASTM D-2887) per ASTM D2887
Conductivity per ASTM D2624
Cetane Index (calculated) per ASTM D976

In addition to the analytical results from the aforementioned tests, the level of antioxidant and corrosion inhibitor / lubricity improver additives will be included on the (C<sub>ofA</sub>). In addition to the analytical tests for the (C<sub>ofA</sub>), the contract requires a set of analysis on the FT Research Fuel corresponding to the (C<sub>ofA</sub>) to be performed. These tests, which will be performed by Southwest Research Institute and are as follows:

**Table B-2. Third Party Analytical Tests**

Particulate per ASTM D5452
Viscosity @ -20°C per ASTM D445 LT
Copper Strip Corrosion (2 hr @ 100C) per ASTM D130
Aromatic Carbon per ASTM D529 93
Sulfur, Total per ASTM D5453
Net Heat of Combustion per ASTM D4809
Hydrogen Content per ASTM D3701
Smoke Point per ASTM D1322

The approval to ship the FT Research Fuel will be based solely on the analytical results associated with the Syntroleum provided Certificate of Analysis, Table B-1 above, certifying that the FT Research Fuel meets the specification ranges set forth by the subcontract.

### FT Shipping and Handling

Groendyke Transport Inc is tentatively scheduled for the shipping of all FT Research Fuel to the designated discharge locations. In accordance with specification requirements for workmanship, the finished FT Research Fuel shall be visually free from undissolved water, sediment, or suspended matter and shall be clear and bright. The transport trucks will be cleaned prior to the loading of the finished FT Research Fuel. As previously discussed and agreed upon with AF representatives, the transport truck cleaning will utilize a food grade quality detergent which contains a mild caustic component followed by a steam clean of approximately 435 °F.

Syntroleum will arrange for transportation of the FT Research Fuel upon completion of the Certificate of Analysis of each ISO container based upon the delivery requirements of the subcontract. To minimize cost, Syntroleum based the project cost on scheduling delivery of the product upon production of a full truckload, approximately 7,500 gallons, or the required delivery amount. Based on a production rate of 1,500 gallons of FT Research Fuel per day, it is anticipated that a truck shipment will be scheduled weekly. Syntroleum has minimal on-site storage for finished product and therefore the shipment of finished FT Research Fuel upon completion of a truckload or required volume for the designated site is required or additional cost would be incurred. The transport trucks will be filled in accordance with safety standards and all transportation will be in accordance with applicable Department of Transportation and Department of Defense regulations governing transportation of aviation fuels.

Upon completion of filling a transport truck, three samples will be taken for shipment to Wright-Patterson Air Force Base (WPAFB). The samples, consisting of two 5 gallon and one 1 gallon containers will be of the contents of the truck shipment and not the ISO container. The samples will be sent to WPAFB as per the subcontract.

Each truck shipment prior to leaving the Syntroleum plant will have all access points sealed except any required to remain unsealed by law. The Bill of Lading information regarding each truck shipment will contain information regarding the seals (ID No.), volume, and ISO container number(s) for the shipment.

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## **APPENDIX C – Investigation Report**

### Key Facts:

1. Mr. Tim Mudry of the AFPET and Mr. Robert Morris Jr. (AFRL/PRTG) traveled to Patuxent River to investigate the contamination issue. Supplementing our efforts were Mr. Mike Young (DESC), Mr. Todd Warren (UTC) and Mr. Bill McCuddy (UTC). Patuxent River participants included Mr. Jack Buffin and Mr. Chas Emberger.
2. Following the halting of defueling at Patuxent River due to the discovery of contamination, the transport company, Groendyke Transport, sequestered the truck and trailer at a truck stop in Jessup MD awaiting the arrival of the investigation team. The truck and trailer were returned to Patuxent River for the investigation on the morning of the August 16th.
3. Upon arrival at the Patuxent River facility, we inspected the samples taken by Jack Buffin during the delivery on the 14th. Jack presented preliminary analysis of some of the debris. Preliminary findings indicate that debris isolate from the tank hose was mostly inorganic. There was also evidence of water along with the metal oxides. 73 percent of these deposits were ferrous material with 17% being tin. When a sample was ashed, the ash content was over 70%.
4. The truck driver positioned the delivery truck in the same approximate position it was in during the off-load on the 14th. With his cooperation, the team inspected the truck hoses and product pump for evidence of the source of the contamination. The Patuxent River facility was also inspected for the same. The team found that three of the four hoses used for the off-load did indeed appear to be new. The fourth, a used hose, appeared to be in excellent condition with no indication of contamination or degradation. The new hoses were also inspected and no evidence of contamination or degradation in the hose or couplings was observed. While the debris observed in the fuel samples was black, the interior lining of all hoses were white and there was no evidence of any sealing material around the couplings that could be the source of this black solids contamination. The entire tank and piping at the Patuxent facility is stainless steel and showed no evidence that could be regarded as a source of the contamination.
5. With the cooperation of the driver, the inlet and outlet pipes to the on-truck pump were opened for inspection. There was significant evidence of dark solids contamination in both the inlet and exit pipes. Patuxent River provided a 4mm borescope that was used to inspect the inlet and outlet housings of the gear pump. A substantial amount of black debris was found in both the inlet and outlet pump housings. This debris was consistent with the debris obtained by Patuxent River during the 14 Aug defuel in both appearance and structure. At both the inlet and outlet of the pump small depressions were noted that would provide a collecting place for debris during pump operation. Most of the debris collected was from these areas. Also, during the inspection of the pump with the borescope, a few drops of product dripped out of the inlet and outlet fuel lines connected to the pump. This fluid was honey-colored indicating that some of the contamination was liberated during the inspection process. This further reinforces that the debris was pump related.
6. On-truck driver records indicated that the pump was last cleaned on 4 Aug and was not used until the defuel operation on the 14th. With temperatures in the 80's and 90's in the region during this time period, along with the pump being made of cast iron, a significant amount of corrosion could've resulted inside the pump between Aug 4th and Aug 14th. This is the most likely source



of some of the debris. It is unknown at this time what exact cleaning procedure was used to clean the pump on Aug 4th. This information will be requested from Syntroleum/Groendyke.

Preliminary Conclusions:

1. From visual analysis and inspection of the debris and the truck pump and hose hardware, the team consensus is that the most likely source of the contamination was the truck pump used to off-load the fuel. The team does not believe the hoses were involved in the contamination.
2. From the description of the off-load process given by the Groendyke driver and Patuxent River personnel the most likely scenario for the contamination was as follows
  - a. All hose and pump connections were made and the defuel was started
  - b. Since the truck load was 6100 gallons and the Patuxent River storage tank capacity was 4600 gallons, the defuel operation was stopped before 100% defuel was completed.
  - c. To stop the defuel, the valve on the facility receipt side was closed and then approximately 30 seconds later, the truck pump was disengaged. The hoses were then removed from the facility connection and drained - at which time the contamination was discovered. It is the team consensus that during the approximately 30 seconds between the time the facility valve was shut off and the disengagement of the off-load pump, the pump operation resulted in a significant amount of 'churning' of the fuel in the pump itself due to the pump dead-heading. This churning turbulence disengaged debris from the pump housing manifold walls and suspended this debris in the fuel in the housing and lines near the pump. When the hoses were disconnected and drained, this debris came out with the fuel.

Next Steps:

1. The primary concern now is the status of the 4600 gallons of fuel in the Patuxent River tank - is it OK to use or not? To determine the status of this fuel, samples will be taken from the Patuxent River tank and sent to AFRL/PRTG and AFPET for full specification analysis. Patuxent River will also perform appropriate analyses. In addition, a sample will be sent back to Syntroleum. Syntroleum will be asked to re-run the Certificate of Analysis testing and supplemental testing at SWRI to determine if the fuel is the same as it was when it was shipped. If all analyses indicate that the fuel has not been contaminated, the team will recommend that Patuxent River retain the fuel and use it according to their prior plan. If the analyses indicate a contamination that would prohibit the fuel being used in the Navy program, the disposition of the fuel will be determined at that time.
2. The remaining 1500 gallons of fuel, (which is believed to be uncontaminated), is being shipped to AFRL, WPAFB Ohio. It will be defueled into one of the recently cleaned S-Farm tanks. Defuel will be accomplished without using the Groendyke truck pump or hoses. Upon receipt at AFRL, PRTG will assume ownership of the remaining 1500 gallons.
3. Shipment of the remaining 5400 gallons to Patuxent River will be suspended until the completion of the analyses of the initial 4600 gallons and until a method can be found to defuel a Groendyke trailer without the risk of contamination.
4. During all future off-loads, receivers will be instructed to draw a 1- to 5-gallon sample at the facility connection point for visual inspection to confirm that the fuel is not being contaminated during the off-load. If contamination is noted, the contamination will be immediately reported to

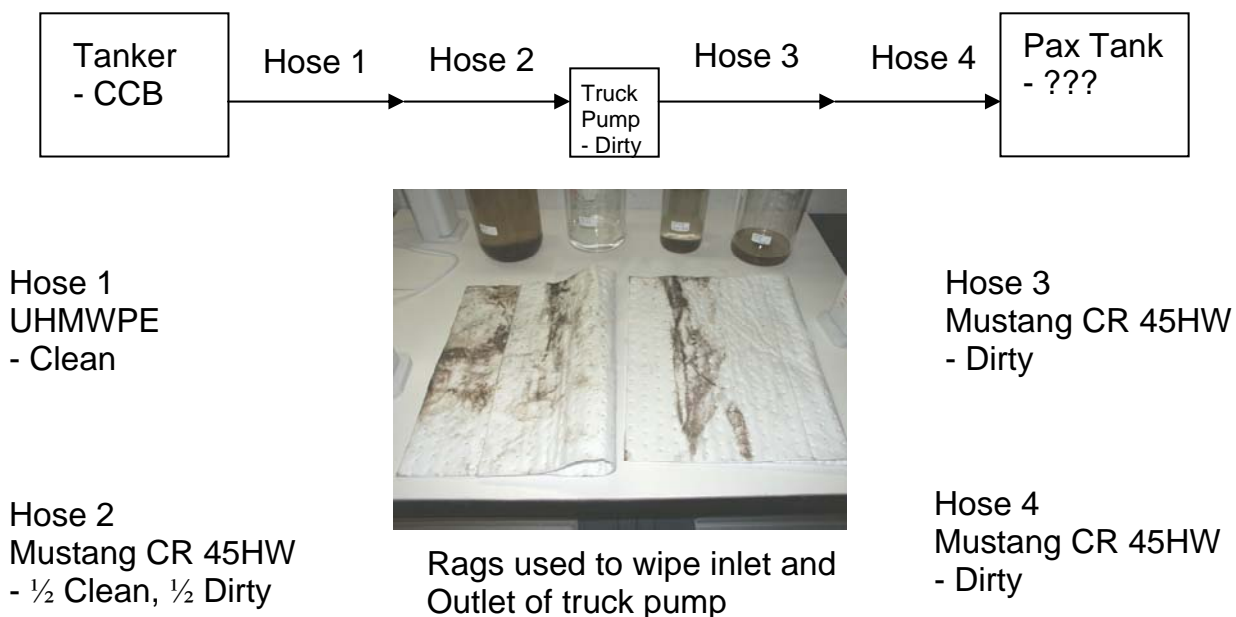
Syntroleum, UTC and AFRL and receipt will be postponed until a determination is made about whether the fuel can be accepted or not.

5. Prior to any future off-loads using a Groendyke-provided pump, procedures should be developed to assure that proper pump cleaning is accomplished and that the pumps are free of contaminants just prior to use.

**Robert W. Morris Jr.**

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!SUPPORT OUR TROOPS!

## Fuel Delivery Setup



All hoses were 2 inches

**Figure C-1. Fuel Delivery Setup**

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# **APPENDIX D**

## **Syntroleum Final Report**

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# **Syntroleum Corporation**

## **Final Report**

**For**

**Universal Technology Corporation**

**Subcontract: 06-S530-0042-02-C1**



**December 2006**

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## 1.0 **INTRODUCTION**

As part of U.S. Air Force contract F33615-02-D-2299, Rapid Response Research and Development (RR&D) Program Universal Technology Corporation (UTC), the prime contractor, is required to provide research and development support and advisory and administrative assistance in various technological areas that include, but are not necessarily limited to, aircraft gas turbine engines, aerospace power, and advanced propulsion for the Propulsion Directorate of the Air Force Research Laboratory (AFRL) at Wright-Patterson AFB, Ohio.

UTC subcontracted to Syntroleum Corporation, under subcontract 06-S530-0042-02-C1 to produce 100,000 gallons of Fischer-Tropsch Research Fluid (FTRF) meeting the specifications outlined in Appendix B and to arrange for shipping to the locations designated in the Subcontract and subsequent modifications. The FTRF was made from natural gas, with a typical composition as shown in Appendix A.

The initial subcontract was executed on June 7, 2006 between Syntroleum and UTC. Subsequent to the initial subcontract, modifications were executed as follows:

Modification 1	June 29, 2006
Modification 2	August 22, 2006
Modification 3	October 11, 2006

This Final Report document is a required deliverable as defined by Part I, Section 3.6 of the Subcontract.

### 1.1 **The Syntroleum® Process**

The Syntroleum® process involves two catalytic reactions: (1) conversion of natural gas into synthesis gas (syngas) in the Syntroleum flameless autothermal reformer (ATR); and (2) conversion of the syngas into hydrocarbons over Syntroleum's proprietary Fischer-Tropsch catalyst.

The flameless ATR in the Syntroleum® process is similar to units used for over 30 years in the ammonia industry. Different generations of Syntroleum's ATR design have operated since November 2003 in our Catoosa Demonstration Facility and have been operating since 1995 as the sole source of syngas for Syntroleum's two bbl/day pilot plant facility in Tulsa, Oklahoma. An earlier generation of this reformer design was also operated for over 6,500 hours at a 70 bbl/day demonstration facility with one of our licensees in the state of Washington. The nitrogen in the gas entering the ATR passes through the reactor essentially unchanged.

### 1.2 **The Synfining® Process**

Syntroleum's Synfining® process was used for the conversion of the Fischer-Tropsch products into the FTRF. The Synfining® process is capable of producing



a wide range of products including diesel fuels, jet fuels (subject to certification), lubricants and specialty chemical feedstocks. The high purity and highly paraffinic, or waxy, nature of the Fischer-Tropsch products generally require lower temperature processing conditions than conventional petroleum-derived feedstocks to obtain high yields of the desired products. This refining technology has been used to produce fuels for testing by the DOE in its Ultra-Clean Fuels Program, automobile manufacturers in the United States and Japan as well as by the DOD and DOT.

### **1.3 Syntroleum's Catoosa Demonstration Facility**

The DOE entered into a cooperative research and development agreement in 2001 with Integrated Concepts and Research Corporation [DE-FC26-01NT41099] to provide funding for the manufacture of ultra-clean Fischer-Tropsch fuels utilizing the Syntroleum® and Synfining® processes. In connection with the performance of that project, Syntroleum relocated certain modules of its process technology from the Cherry Point GTL facility at ARCO's refinery in the state of Washington to the Port of Catoosa near Tulsa, Oklahoma. The Syntroleum® and Synfining® processes and these modules became the basis for the construction of the Syntroleum Catoosa Demonstration Facility (CDF), a demonstration plant designed to produce up to 70 bbl/day of synthetic products and simulate a commercial-scale GTL facility. With the assistance and participation of Marathon Oil Company, a licensee of the Syntroleum® process, the CDF was mechanically completed and dedicated on October 3, 2003. Syntroleum commenced the startup of the facility and fuel deliveries in the first quarter of 2004. The fuels from the CDF have been tested in advanced power train and emission control technologies, as well as being tested in bus fleets by the Washington Metropolitan Area Transit Authority and the U.S. National Park Service at Denali National Park in Alaska.

## **2.0 PRODUCTION OF FTRF**

During its efforts toward this subcontract with UTC, Syntroleum produced and delivered 104,091 gallons of FTRF. Production of on-spec FTRF began on June 25, 2006, a day earlier than scheduled. Production finished on August 22, 2006, for a total production time of 58 days. The estimated production schedule was for completion on September 3, 2006, for an estimated total of 69 days of production. Syntroleum was able to substantially beat the estimated production schedule for three reasons: 1) the feed rate was maintained at a higher rate than initially expected; 2) the weather during the production run was relatively stable with few severe thunderstorms that may have resulted in power interruptions (this did occur only twice); and, 3) the equipment ran very well with only one shutdown for unusual maintenance or repair.

## 2.1 QA/QC During Production

FTRF was produced directly into ISO-containers (nominal 6,000 gallon capacity). Prior to first use, each ISO was cleaned and given a Certificate of Cleanliness. Appendix C contains a listing of ISO-containers in the order that they were filled, listing the number of gallons per ISO and the date that each ISO was filled. In cases where ISO's were re-used (after filling from production and then emptying for shipment), alpha designations were added to the end of the ISO number, thus creating a unique identifying number for the next production lot. ISO's were not cleaned in between these subsequent fillings since they were handling the exact same product.

During production, Syntroleum checked product quality three (3) times per day by sending 8 oz sample jars to Syntroleum's Lab testing for:

- Density at 15°C
- Flash Point
- Freezing Point
- Distillation (D2887)
- Viscosity at 40°C

Once the FTRF passed initial specification on June 25, 2006, production was only interrupted on three occasions; twice due to power failures from thunderstorms and once due to an instrument malfunction that caused a shutdown. In all three cases, Operations shifted production to the "off-spec" ISO and then worked to return the system to normal operating conditions. When run conditions were restored back to pre-shutdown settings, special samples were sent to the Syntroleum Lab. In all three cases, the first sample came back "on-spec" and production was transferred back to the normal production ISO.

## 2.2 FTRF Additives

The FTRF was additized with the following materials:

Antioxidant (AO)	2,6-di-tert-butylphenol (BHT)
Corrosion Inhibitor/Lubricity Improver (CI/LI)	Octel DCI-4A
Conductivity (SDA)	Stadis 450

The amounts of each additive were in accordance with Appendix A (Revision 1 21 June 06) of the Subcontract. The concentration range for the AO was specified as 17.2mg/l to 24.0 mg/l of active ingredient. This material was supplied by Syntroleum. The concentration range for the CI/LI was specified as 13 g/m<sup>3</sup> to 17 g/m<sup>3</sup> with a target value of 15 g/m<sup>3</sup>. For conductivity, the specification stated that the fuel shall be maintained at between 150 and 450 pS/m as per MIL-DTL-83133E Table 1 (Footnote 11). It was agreed that conductivity would be reported at 85°F for the purpose of meeting this specification. The Octel

DCI-4A and the Stadis 450 were supplied to Syntroleum by the AFPET as part of the contract.

Additive packages were prepared by the Syntroleum Lab. Operations would request an additive package based on the number of gallons planned for that particular ISO. ISO's were normally filled to 6,000 gallons; however, some were filled to 5,000 gallons to help with shipping logistics. The final ISO contained only 1,500 gallons at the end of the run and a special additive package was prepared for that amount. Each additive package was poured into a five gallon bucket and mixed thoroughly with FTRF. The mix was then added to the ISO after at least 1,000 gallons of FTRF had filled into the ISO.

### **2.3 Certificates of Analysis**

When each ISO was filled to its specified level, production was shifted to the next ISO to be filled. The filled ISO was then rolled with nitrogen for 45 minutes to ensure thorough mixing of the FTRF and additives. Samples were then taken and sent to the Syntroleum Lab for creation of the "Internal" and "External" Certificate of Analysis (C of A). The Internal C of A testing included the following:

- Density at 15°C
- API Gravity at 60°F
- Ash Content
- Flash Point
- Freezing Point
- Color
- Viscosity at 40°C
- Distillation (D2887)
- Conductivity at 85°F
- Cetane Index (Calculated)

The level of AO and CI/LI additives are also shown on the Internal C of A.

The External C of A testing included the following:

- Copper Strip Corrosion (2 hr @ 100°C) per ASTM D130
- Hydrogen Content by NMR (min) per ASTM D3701
- Particulates (max) per ASTM D2276
- Kinematic viscosity (max) @ -20°C per ASTM D445
- Aromatic Carbon (max) per ASTM D5292
- Smoke Point (min) per ASTM D1322
- Net Heat of Combustion (min) per ASTM D4809
- Total Contamination per ASTM D5452
- Sulfur, Total (max) per ASTM D5453

All of the above tests were completed at SwRI in San Antonio with the exception of the Hydrogen Content by NMR, which was done at Oral Roberts University in Tulsa.

In all, nineteen (19) ISO-containers were filled (or partially filled) during the production run. Attachments 1 through 19 include summary details for each ISO plus the Internal and External C of A's for each ISO.

### **3.0 DELIVERIES OF FTRF**

Delivery locations and quantities were specified in the Subcontract and its modifications. The actual schedule of deliveries is listed in Appendix D.

All deliveries were made by Groendyke Transport Inc. using tanker trucks. The tankers were first cleaned prior to loading using a food grade caustic wash followed by a rinse and steaming at approximately 435°F. Tankers were not cleaned if they had carried no other load prior to refilling at Syntroleum. This was this case for the five loads that went to Tinker AFB. After the initial cleaning, the same tanker was used for all five loads. In almost all other cases, tankers had to be cleaned prior to loading.

After the tankers were loaded, a total of 11 gallons of samples were taken from the tanker as follows: two 5-gallon sample cans and one 1-gallon sample can. These cans were then shipped to Wright-Patterson AFB. Overall, there were 18 fuel shipments by tanker truck and 18 sets of sample cans sent to W-P AFB.

### **4.0 PROBLEMS ENCOUNTERED**

Overall, the contract ran very smoothly with few problems. When problems were encountered, they were worked through very quickly. Below are the details of the two most significant problems that were encountered.

#### **4.1 High Conductivity**

Initially, there was a problem with knowing how much of the conductivity additive, Stadis 450, to put in to achieve the conductivity specification. As a result, the first two ISO's loaded were higher in conductivity than allowed. Syntroleum's Lab immediately adjusted the amount of Stadis 450 and the problem was solved for all ISO's going forward. The first of the two ISO's with high conductivity was blended down with fresh production to meet the conductivity specification. Syntroleum was intending to follow the same procedure to blend down the second ISO when UTC and the Air Force decided to accept the high conductivity material at Tinker AFB in order to have sufficient fuel for the testing there. The Air Force determined that the high conductivity was only a problem on aircraft and that the Tinker tests were to be ground based engine tests. This close

cooperation allowed the Air Force to get the fuel that they needed and saved Syntroleum the effort of further blending.

#### **4.2 Contamination During Unloading at Patuxent River**

On August 11, 2006, a tanker truck containing 6,100 gallons of FTRF was dispatched to Patuxent River Naval Air Station (Pax River) in Maryland. The Groendyke tanker truck arrived at Pax River on August 14, 2006. To that point, nine other deliveries had been made, always using the equipment on the ground at location to unload the FTRF. Pax River did not have such equipment and used the pump on the truck to unload from the truck's tanker into their tankage on site. Pax River was using multiple tanks to hold the FTRF and had unloaded approximately 4,600 gallons into one tank. That tank was full and they were proceeding to switch to a second tank when they noticed that the FTRF coming out of the transfer hose had been contaminated. The color had changed and they could visibly see solids in the product. They stopped the transfer at that point and an investigation was started immediately. The investigation revealed that the source of the contamination was the truck pump used to transfer the product. The investigation determined that the contamination did not occur until after all 4,600 gallons had been transferred. The operator closed the valve to the tank before turning off the pump. The pump subsequently "dead-headed" for some period of time and that seemed to have caused residual material in the pump to break free, thus contaminating the FTRF in the pump and hoses. The remainder of the load, about 1,500 gallons, was sent to Wright-Patterson AFB where it could be unloaded without use of the truck pump. Syntroleum confirmed that the 4,600 gallons unloaded at Pax River were not contaminated by reproducing all tests for new Internal and External C of A's (see Attachment 13). As a result of this experience, Groendyke instituted a pump cleaning process, similar to the tank cleaning process and provided a Certificate of Cleanliness for the truck pump when required. There were no other problems with contamination after this incident.

## APPENDIX A

### TYPICAL NATURAL GAS FEED COMPOSITION

Component	Symbol	Range (mol%)		Typical
		Min	Max	(mol%)
Nitrogen	N2	1.343	2.410	1.86
Hydrogen	H2	0.021	0.104	0.06
Carbon Dioxide	CO2	0.208	0.741	0.47
Methane	CH4	91.980	95.557	93.60
Ethanes	C2H6	2.063	4.510	3.29
Propanes	C3H8	0.200	0.870	0.55
Butanes	C4H10	0.035	0.192	0.11
Pentanes	C5H12	0.013	0.072	0.04
Hexanes	C6H14	0.009	0.029	0.02
TOTAL				100.00

## APPENDIX B

FTRF PROPERTIES			
Physical Properties	Test Method	Units	Specification Value
Density	ASTM D4052	kg/l	0.75 - 0.77
API Gravity	ASTM D4052	°	51.6 - 56.5
Ash, max	ASTM D482	wt%	0.001
Flash Point, min	ASTM D93	°C	38
Freeze Point, max	ASTM D5972	°C	-47
Color	ASTM D156	Saybolt	Report
Particulates, max	ASTM D2276 or ASTM D5452	mg/l	1.0
Kinematic Viscosity, max @ -20°C	ASTM D445	cSt	<8.0
Kinematic Viscosity, @ 40°C	ASTM D445	cSt	1.3 - 1.9
Distillation, % recovered	ASTM D86 (D2887)	°C	
<i>IBP</i>		°C	Report
<i>10% Recovered, max</i>		°C	205 (186)
<i>20% Recovered</i>		°C	Report
<i>50% Recovered</i>		°C	Report
<i>90% Recovered</i>		°C	Report
<i>FBP, max</i>		°C	300 (330)
Copper Strip Corrosion, 2 hr at 100°C	ASTM D130		No. 1
Aromatic Carbon, max	ASTM D5292	Mol %	< 0.5
Sulfur, Total, Max	ASTM D5453	ppm	1
Cetane Index	ASTM D976		Report
Net Heat of Combustion, min	ASTM D4809	MJ/kg (BTU/lb)	>42.8 (18397)
Hydrogen Content, min	ASTM D3701 or D3343	Mass %	>15
Smoke Point, min	ASTM D1322	mm	>40
Conductivity @ 85°F	ASTM D2624	pS/m	150-450

## APPENDIX C

### FTRF PRODUCTION

Number	ISO #	Gallons	Date Filled
1	124166-7	6,008	1-Jul-06
2	124136-9	5,995	3-Jul-06
3	124239-1	5,988	6-Jul-06
4	124146-1	6,105	8-Jul-06
5	124169-3	5,119	11-Jul-06
6	124248-9	4,850	15-Jul-06
7	124146-1B	5,050	17-Jul-06
8	124169-3B	5,000	20-Jul-06
9	124136-9B	6,094	23-Jul-06
10	124166-7B	5,100	26-Jul-06
11	124239-1B	4,728	29-Jul-06
12	124146-1C	6,105	1-Aug-06
13	124248-9C	6,100	5-Aug-06
14	124169-3C	6,105	8-Aug-06
15	124261-6	6,126	12-Aug-06
16	124136-9C	6,092	15-Aug-06
17	124166-7C	6,000	18-Aug-06
18	124248-9D	6,026	22-Aug-06
19	124013-0	1,500	22-Aug-06
	TOTAL	<b>104,091</b>	Gallons

Attachments 1 through 19 are in the same order as the table above.



## APPENDIX D

### FTRF DELIVERIES

Shipment Number	Gallons Shipped	Location	Ship Date	ISO #	Gallons
1	6,008	Tinker AFB	10-Jul-06	124166-7	6,008
2	5,988	Tinker AFB	11-Jul-06	124239-1	5,988
3	6,105	Tinker AFB	12-Jul-06	124146-1	6,105
4	5,119	Tinker AFB	13-Jul-06	124169-3	5,119
5	5,995	Tinker AFB	14-Jul-06	124136-9	5,995
6	6,800	SwRI	24-Jul-06	124248-9	4,850
				124146-1B	1,950
7	6,800	Edwards AFB	25-Jul-06	124146-1B	3,100
				124169-3B	3,700
8	6,800	Edwards AFB	31-Jul-06	124169-3B	1,300
				124136-9B	5,500
9	6,800	Edwards AFB	4-Aug-06	124136-9B	594
				124166-7B	5,100
				124146-1C	1,106
10	4,600	Pax River	11-Aug-06	124248-9C	6,100
	1,500	W-P AFB			
11	2,300	Selfridge	16-Aug-06	124146-1C	2,300
12	6,092	Edwards AFB	21-Aug-06	124136-9C	6,092
13	6,126	Edwards AFB	28-Aug-06	124261-6	6,126
14	6,105	Edwards AFB	28-Aug-06	124169-3C	6,105
15	5,400	Pax River	12-Sep-06	124146-1C	2,699
				124239-1B	2,701
16	6,000	W-P AFB	15-Sep-06	124166-7C	6,000
17	6,026	W-P AFB	18-Sep-06	124248-9D	6,026
18	3,527	W-P AFB	19-Sep-06	124239-1B	2,027
				124013-0	1,500
<b>TOTAL</b>	<b>104,091</b>	Gallons			

**SYNTROLEUM  
CERTIFICATE OF ANALYSIS  
DOCUMENTS**

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# Certificate of Analysis – Isoparaffinic Synthetic Distillate



THIS SYNTROLEUM FISCHER-TROPSCH SYNTHETIC RESEARCH FLUID HAS BEEN PRODUCED FOR THE DEPARTMENT OF DEFENSE PURSUANT TO A FIXED FEE PLUS COST-REIMBURSEMENT U.S. GOVERNMENT CONTRACT, NUMBER F33615-02-D-2299

ISO CONTAINER NUMBER: 124166-7

DATE OF TESTING: 1-Jul-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.756
API @ 60 °F	ASTM D-4052		51.6	56.5	55.5
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		50
Freezing Point	ASTM D-5972	°C		-47	-50.5
Color	ASTM D-156	Saybolt		Report	+27
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.319
Distillation, IBP,%	ASTM D-2887	°C		Report	118
10% recovered		°C		186	152
20% recovered		°C		Report	173
50% recovered		°C		Report	210
90% recovered		°C		Report	259
FBP		°C		330	280
Conductivity @ 68.8/85 °F	ASTM D-2624	pS/m	150	450	334/414
Cetane Index (calculated)	ASTM D-976			Report	67.7
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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## SYNTROLEUM QA/QC APPROVAL

*Christine J. King*

Authorized Signature

JULY 6, 2006

Date

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ISO CONTAINER NUMBER:Iso 124166-7

DATE OF TESTING:15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.41
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.55
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18993.2
Aromatic carbon	ASTM D 529 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.4
Sulphur	ASTM D-5453	ppm			0.2

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15AUG06

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ISO CONTAINER NUMBER: 124239-1

DATE OF TESTING: 6-Jul-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.756
API @ 60 °F	ASTM D-4052		51.6	56.5	55.6
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		48
Freezing Point	ASTM D-5972	°C		-47	-50.5
Color	ASTM D-156	Saybolt		Report	+28
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.378
Distillation, IBP, %	ASTM D-2887	°C		Report	114
10% recovered		°C		186	151
20% recovered		°C		Report	173
50% recovered		°C		Report	209
90% recovered		°C		Report	258
FBP		°C		330	282
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	370
Cetane Index (calculated)	ASTM D-976			Report	67.7
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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7JUL06

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ISO CONTAINER NUMBER:Iso 124239-1

DATE OF TESTING:15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.44
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.50
Aromatic carbon	ASTM D 529 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18917.0
Total Contamination	ASTM D-5452	mg/L		1.0	0.4
Sulphur	ASTM D-5453	ppm			0.4

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ISO CONTAINER NUMBER: 124146-1

DATE OF TESTING: 08-Jul-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.756
API @ 60 °F	ASTM D-4052		51.6	56.5	55.6
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		49.0
Freezing Point	ASTM D-5972	°C		-47	-50.0
Color	ASTM D-156	Saybolt		Report	+28
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.333
Distillation, IBP,%	ASTM D-2887	°C		Report	114
10% recovered		°C		186	151
20% recovered		°C		Report	172
50% recovered		°C		Report	209
90% recovered		°C		Report	258
FBP		°C		330	278
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	360
Cetane Index (calculated)	ASTM D-976			Report	67.7
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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08-JUL-06

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ISO CONTAINER NUMBER:Iso 124146-1

DATE OF TESTING:15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			14.78
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.53
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		19004.3
Aromatic carbon	ASTM D 529 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.5
Sulphur	ASTM D-5453	ppm			0.6

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ISO CONTAINER NUMBER:Iso 124169-3

DATE OF TESTING:15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.55
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.48
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18921.1
Aromatic carbon	ASTM D 529 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.20
Sulphur	ASTM D-5453	ppm			0.4

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**CONTACT:** SYNTROLEUM CORPORATION  
4322 SOUTH 49<sup>TH</sup> WEST AVENUE  
TULSA, OKLAHOMA 74107  
(918) 592-7900

## SYNTROLEUM QA/QC APPROVAL

*Christine A. King*

Authorized Signature

15AUG06

Date

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# Certificate of Analysis – Isoparaffinic Synthetic Distillate



THIS SYNTROLEUM FISCHER-TROPSCH SYNTHETIC RESEARCH FLUID HAS BEEN PRODUCED FOR THE DEPARTMENT OF DEFENSE PURSUANT TO A FIXED FEE PLUS COST-REIMBURSEMENT U.S. GOVERNMENT CONTRACT, NUMBER F33615-02-D-2299

ISO CONTAINER NUMBER: ISO 124169-3

DATE OF TESTING: 06Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.45
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.52
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18965.8
Total Contamination	ASTM D-5452	mg/L		1.0	0.30
Sulphur	ASTM D-5453	ppm			0.8

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*Christine A. King*

Authorized Signature

06SEP06

Date

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ISO CONTAINER NUMBER: 124136-9

DATE OF TESTING: 5-Jul-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.757
API @ 60 °F	ASTM D-4052		51.6	56.5	55.5
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		52.7
Freezing Point	ASTM D-5972	°C		-47	-50.0
Color	ASTM D-156	Saybolt		Report	+28
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.348
Distillation, IBP,%	ASTM D-2887	°C		Report	117
10% recovered		°C		186	159
20% recovered		°C		Report	174
50% recovered		°C		Report	211
90% recovered		°C		Report	258
FBP		°C		330	278
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	1121
Cetane Index (calculated)	ASTM D-976			Report	67.6
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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## SYNTROLEUM QA/QC APPROVAL

*Christine J. King*

Authorized Signature

13-JUL-06

Date

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THIS SYNTROLEUM FISCHER-TROPSCH SYNTHETIC RESEARCH FLUID HAS BEEN PRODUCED FOR THE DEPARTMENT OF DEFENSE PURSUANT TO A FIXED FEE PLUS COST-REIMBURSEMENT U.S. GOVERNMENT CONTRACT, NUMBER F33615-02-D-2299

ISO CONTAINER NUMBER:Iso 124136-9

DATE OF TESTING:15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.50
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.69
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18938.1
Aromatic carbon	ASTM D 529 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.22
Sulphur	ASTM D-5453	ppm			0.7

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Authorized Signature

15AUG06

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ISO CONTAINER NUMBER: 124248-9

DATE OF TESTING: 17-Jul-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.755
API @ 60 °F	ASTM D-4052		51.6	56.5	55.6
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		48.0
Freezing Point	ASTM D-5972	°C		-47	-50.0
Color	ASTM D-156	Saybolt		Report	+28
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.326
Distillation, IBP,%	ASTM D-2887	°C		Report	114
10% recovered		°C		186	151
20% recovered		°C		Report	172
50% recovered		°C		Report	210
90% recovered		°C		Report	260
FBP		°C		330	280
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	233
Cetane Index (calculated)	ASTM D-976			Report	67.9
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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Authorized Signature

17-JUL-06

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ISO CONTAINER NUMBER:Iso 124248-9

DATE OF TESTING:15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.53
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.48
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18918.8
Aromatic carbon	ASTM D 529 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.45
Sulphur	ASTM D-5453	ppm			0.8

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ISO CONTAINER NUMBER:124146-1B

DATE OF TESTING: 19-Jul-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.755
API @ 60 °F	ASTM D-4052		51.6	56.5	55.9
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		47.0
Freezing Point	ASTM D-5972	°C		-47	-50.5
Color	ASTM D-156	Saybolt		Report	+28
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.328
Distillation, IBP,%	ASTM D-2887	°C		Report	114
10% recovered		°C		186	151
20% recovered		°C		Report	169
50% recovered		°C		Report	209
90% recovered		°C		Report	259
FBP		°C		330	280
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	356
Cetane Index (calculated)	ASTM D-976			Report	68.2
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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## SYNTROLEUM QA/QC APPROVAL

*Christine J. King*

Authorized Signature

JULY 21, 2006

Date

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ISO CONTAINER NUMBER:Iso 124146-1B

DATE OF TESTING:15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.44
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.47
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18921.2
Aromatic carbon	ASTM D 529 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.28
Sulphur	ASTM D-5453	ppm			0.6

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15AUG06

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ISO CONTAINER NUMBER: ISO 124136-9B

DATE OF TESTING: 24Jul06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	55.9
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		46.0
Freezing Point	ASTM D-5972	°C		-47	-49.5
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.321
Distillation, IBP, %	ASTM D-2887	°C		Report	114
10% recovered		°C		186	151
20% recovered		°C		Report	168
50% recovered		°C		Report	210
90% recovered		°C		Report	263
FBP		°C		330	282
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	272
Cetane Index (calculated)	ASTM D-976			Report	68.6
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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## SYNTROLEUM QA/QC APPROVAL

*Christine A. King*  
Authorized Signature

24-JUL-06  
Date

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ISO CONTAINER NUMBER:Iso 124136-9B

DATE OF TESTING:06Sept06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.38
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.45
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		19025.7
Aromatic carbon	ASTM D 5292- 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.28
Sulphur	ASTM D-5453	ppm			0.6

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ISO CONTAINER NUMBER: 124169-3B

DATE OF TESTING: 20 Jul 06

*2nd level*  
*1300 Gallons* *shd 7/21/06*

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	55.9
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		47.0
Freezing Point	ASTM D-5972	°C		-47	-50.0
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.334
Distillation, IBP, %	ASTM D-2887	°C		Report	113
10% recovered		°C		186	151
20% recovered		°C		Report	168
50% recovered		°C		Report	209
90% recovered		°C		Report	261
FBP		°C		330	281
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	338
Cetane Index (calculated)	ASTM D-976			Report	68.1
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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## SYNTROLEUM QA/QC APPROVAL

*Christine A. King*

20 JUL 06

Authorized Signature

Date

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# Certificate of Analysis – Isoparaffinic Synthetic Distillate

**Syntroleum®**

THIS SYNTROLEUM FISCHER-TROPSCH SYNTHETIC RESEARCH FLUID HAS BEEN PRODUCED FOR THE DEPARTMENT OF DEFENSE PURSUANT TO A FIXED FEE PLUS COST-REIMBURSEMENT U.S. GOVERNMENT CONTRACT, NUMBER F33615-02-D-2299

ISO CONTAINER NUMBER: 124166-7B

DATE OF TESTING: 25-Jul-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	56.0
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		45.0
Freezing Point	ASTM D-5972	°C		-47	-49.0
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.320
Distillation, IBP, %	ASTM D-2887	°C		Report	114
10% recovered		°C		186	151
20% recovered		°C		Report	167
50% recovered		°C		Report	210
90% recovered		°C		Report	263
FBP		°C		330	283
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	335
Cetane Index (calculated)	ASTM D-976			Report	68.7
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15

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**CONTACT:** SYNTROLEM CORPORATION  
4322 SOUTH 49<sup>TH</sup> WEST AVENUE  
TULSA, OKLAHOMA 74107  
(918) 592-7900

## SYNTROLEUM QA/QC APPROVAL

*Christine A. King*  
Authorized Signature

25-JUL-06  
Date

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ISO CONTAINER NUMBER:Iso 124166-7B

DATE OF TESTING:22Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.29
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.45
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18994.7
Aromatic carbon	ASTM D 5292- 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.22
Sulphur	ASTM D-5453	ppm			0.6

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22AUG06

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ISO CONTAINER NUMBER: Iso 124146-1C

DATE OF TESTING: 01Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	56.1
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		46.0
Freezing Point	ASTM D-5972	°C		-47	-49.0
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.316
Distillation, IBP,%	ASTM D-2887	°C		Report	.114
10% recovered		°C		186	149
20% recovered		°C		Report	166
50% recovered		°C		Report	209
90% recovered		°C		Report	263
FBP		°C		330	283
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	198
Cetane Index (calculated)	ASTM D-976			Report	68.4
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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ISO CONTAINER NUMBER:Iso 124146-1C

DATE OF TESTING:22Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.25
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.42
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18999.7
Aromatic carbon	ASTM D 5292- 93	Mol%			<0.1
Smoke point	ASTM D 1322	mm			Exceeded maximum height
Total Contamination	ASTM D-5452	mg/L		1.0	0.1
Sulphur	ASTM D-5453	ppm			1.3

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22AUG06

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**Syntroleum**

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ISO CONTAINER NUMBER: Iso 124136-9C

DATE OF TESTING: 15Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	50.1
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		46.0
Freezing Point	ASTM D-5972	°C		-47	-49.0
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.334
Distillation, IBP, %	ASTM D-2887	°C		Report	114
10% recovered		°C		186	150
20% recovered		°C		Report	167
50% recovered		°C		Report	210
90% recovered		°C		Report	264
FBP		°C		330	286
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	363
Cetane Index (calculated)	ASTM D-976			Report	68.8
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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15AUG06

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ISO CONTAINER NUMBER:ISO 124136-9C

DATE OF TESTING: 17Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.52
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.45
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum Height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		19046.6
Total Contamination	ASTM D-5452	mg/L		1.0	0.25
Sulphur	ASTM D-5453	ppm			0.6

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Authorized Signature

18SEPT60

Date

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ISO CONTAINER NUMBER:Iso 124261-6

DATE OF TESTING:12Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	55.9
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		45.0
Freezing Point	ASTM D-5972	°C		-47	-49.5
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.329
Distillation, IBP,%	ASTM D-2887	°C		Report	115
10% recovered		°C		186	149
20% recovered		°C		Report	167
50% recovered		°C		Report	210
90% recovered		°C		Report	265
FBP		°C		330	287
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	387
Cetane Index (calculated)	ASTM D-976			Report	67.6
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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## SYNTROLEUM QA/QC APPROVAL

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Authorized Signature

12AUG06

Date

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# Certificate of Analysis – Isoparaﬃnic Synthetic Distillate



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ISO CONTAINER NUMBER:ISO 124261-6

DATE OF TESTING: 17Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.55
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.48
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum Height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18971.1
Total Contamination	ASTM D-5452	mg/L		1.0	0.20
Sulphur	ASTM D-5453	ppm			0.6

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ISO CONTAINER NUMBER:Iso 124169-3C

DATE OF TESTING:08Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	55.9
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		46.0
Freezing Point	ASTM D-5972	°C		-47	-50.5
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.321
Distillation, IBP,%	ASTM D-2887	°C		Report	114
10% recovered		°C		186	149
20% recovered		°C		Report	166
50% recovered		°C		Report	209
90% recovered		°C		Report	263
FBP		°C		330	282
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	284
Cetane Index (calculated)	ASTM D-976			Report	68.1
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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ISO CONTAINER NUMBER:ISO 124169-3C

DATE OF TESTING: 17Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.49
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.44
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum Height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18990.0
Total Contamination	ASTM D-5452	mg/L		1.0	0.10
Sulphur	ASTM D-5453	ppm			0.5

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ISO CONTAINER NUMBER: Iso 124248-9C

DATE OF TESTING: 05-Aug-06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	55.9
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		45.0
Freezing Point	ASTM D-5972	°C		-47	-50.0
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.321
Distillation, IBP, %	ASTM D-2887	°C		Report	114
10% recovered		°C		186	149
20% recovered		°C		Report	166
50% recovered		°C		Report	209
90% recovered		°C		Report	263
FBP		°C		330	282
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	336
Cetane Index (calculated)	ASTM D-976			Report	68.2
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

**Health and Safety:** The product(s) described herein may require precautions in handling and use. If deemed necessary, Material Safety Data Sheets (MSDS) for Syntroleum products are included with this document. You may also obtain this information by writing to us at the address below. Always consult the Material Safety Data Sheet for products you consider using.

CONTACT: SYNTROLEM CORPORATION  
4322 SOUTH 49<sup>TH</sup> WEST AVENUE  
TULSA, OKLAHOMA 74107  
(918) 592-7900

## SYNTROLEUM QA/QC APPROVAL

*Christine A. King*

Authorized Signature

05AUG06

Date

THIS PRODUCT IS EXPERIMENTAL AND SYNTROLEUM CORPORATION MAKES NO REPRESENTATION THAT IT WILL BECOME COMMERCIALY AVAILABLE. THE DATA PROVIDED HEREIN ARE PRESENTED FOR INFORMATION PURPOSES ONLY AND CANNOT BE GUARANTEED TO BE IDENTICAL TO THE PRODUCTS PRODUCED AT ANY TIME. NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING SUCH OTHER INFORMATION, THE DATA UPON WHICH THE SAME IS BASED, OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF; THAT ANY PRODUCT SHALL BE MERCHANTABLE OR FIT FOR ANY PARTICULAR PURPOSE; OR THAT THE USE OF SUCH OTHER INFORMATION OR PRODUCT WILL NOT INFRINGE ANY PATENT.

# Certificate of Analysis – Isoparaffinic Synthetic Distillate



THIS SYNTROLEUM FISCHER-TROPSCH SYNTHETIC RESEARCH FLUID HAS BEEN PRODUCED FOR THE DEPARTMENT OF DEFENSE PURSUANT TO A FIXED FEE PLUS COST-REIMBURSEMENT U.S. GOVERNMENT CONTRACT, NUMBER F33615-02-D-2299

ISO CONTAINER NUMBER: ISO 124248-9C

DATE OF TESTING: 06Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.32
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.46
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum Height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		19005.7
Total Contamination	ASTM D-5452	mg/L		1.0	0.25
Sulphur	ASTM D-5453	ppm			0.6

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06SEP06

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# Certificate of Analysis – Isoparaffinic Synthetic Distillate

Syntroleum®

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ISO CONTAINER NUMBER: 124239-1B

DATE OF TESTING: 29Jul06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	56.1
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		45.0
Freezing Point	ASTM D-5972	°C		-47	-50.0
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.311
Distillation, IBP, %	ASTM D-2887	°C		Report	114
10% recovered		°C		186	149
20% recovered		°C		Report	166
50% recovered		°C		Report	209
90% recovered		°C		Report	263
FBP		°C		330	283
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	163
Cetane Index (calculated)	ASTM D-976			Report	68.5
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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Authorized Signature

29JUL06

Date

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ISO CONTAINER NUMBER: ISO 124239-1B

DATE OF TESTING: 06Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1b
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.43
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.42
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		19085.8
Total Contamination	ASTM D-5452	mg/L		1.0	0.8
Sulphur	ASTM D-5453	ppm			1.0

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06SEP06

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ISO CONTAINER NUMBER:Iso 124166-7C

DATE OF TESTING:18Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.754
API @ 60 °F	ASTM D-4052		51.6	56.5	55.9
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		46.0
Freezing Point	ASTM D-5972	°C		-47	-50.0
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.326
Distillation, IBP,%	ASTM D-2887	°C		Report	114
10% recovered		°C		186	150
20% recovered		°C		Report	167
50% recovered		°C		Report	209
90% recovered		°C		Report	263
FBP		°C		330	283
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	371
Cetane Index (calculated)	ASTM D-976			Report	68.4
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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(918) 592-7900

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*Christine J. King*

Authorized Signature

18AUG06

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ISO CONTAINER NUMBER:ISO 124166-7C

DATE OF TESTING: 17Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.60
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.46
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum Height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		19018.0
Total Contamination	ASTM D-5452	mg/L		1.0	0.50
Sulphur	ASTM D-5453	ppm			0.8

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Authorized Signature

18SEPT60

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ISO CONTAINER NUMBER: Iso 124248-9D

DATE OF TESTING: 22Aug06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.755
API @ 60 °F	ASTM D-4052		51.6	56.5	55.8
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		46.0
Freezing Point	ASTM D-5972	°C		-47	-49.5
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40 °C	1.3	1.9	1.332
Distillation, IBP, %	ASTM D-2887	°C		Report	114
10% recovered		°C		186	144
20% recovered		°C		Report	166
50% recovered		°C		Report	211
90% recovered		°C		Report	266
FBP		°C		330	288
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	389
Cetane Index (calculated)	ASTM D-976			Report	68.6
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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Authorized Signature

22AUG06

Date

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Revision Date: 30 June 2006

Page 1 of 1

# Certificate of Analysis – Isoparaﬃnic Synthetic Distillate



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ISO CONTAINER NUMBER:ISO 124248-9D

DATE OF TESTING: 17Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.57
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.57
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum Height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18952.0
Total Contamination	ASTM D-5452	mg/L		1.0	0.40
Sulphur	ASTM D-5453	ppm			0.6

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Authorized Signature

18SEPT60

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ISO CONTAINER NUMBER: iso 124013-0

DATE OF TESTING: 04Sept06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Density @ 15 °C	ASTM D-4052	kg/L	0.75	0.77	0.755
API @ 60 °F	ASTM D-4052		51.6	56.5	55.8
Ash, max	ASTM D-482	wt%		0.001	<0.001
Flash Point	ASTM D-93	°C	38		44.0
Freezing Point	ASTM D-5972	°C		-47	-49.5
Color	ASTM D-156	Saybolt		Report	+30
Viscosity	ASTM D-445	cSt @ 40°C	1.3	1.9	1.359
Distillation, IBP, %	ASTM D-2887	°C		Report	113
10% recovered		°C		186	143
20% recovered		°C		Report	166
50% recovered		°C		Report	212
90% recovered		°C		Report	267
FBP		°C		330	289
Conductivity @ 85 °F	ASTM D-2624	pS/m	150	450	285
Cetane Index (calculated)	ASTM D-976			Report	67.95
Antioxidant (2,6-di-tert-butylphenol)		mg/L	17.2	24.0	21.0
Corrosion Inhibitor / Lubricity Improver (supplied by AF)		g/m <sup>3</sup>	13	17	15.0

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Authorized Signature

04SEPT06  
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ISO CONTAINER NUMBER:ISO 124013-0

DATE OF TESTING: 22Sep06

PROPERTY	TEST METHOD	UNITS	SPECIFICATION		ACTUAL
			MINIMUM	MAXIMUM	
Copper corrosion	ASTM D-130			1	1a
Hydrogen Content by NMR	ASTM D-3701	Mass%			15.33
Viscosity @ -20 °C	ASTM D-445 LT	cSt		8.0	4.60
Aromatic Carbon	ASTM D5292-93	Mol%			<0.1
Smoke Point	ASTM D-1322	mm			Exceeded maximum Height
Heat of Combustion (Net)	ASTM D-4809	BTU/lb	18400		18977.3
Total Contamination	ASTM D-5452	mg/L		1.0	0.15
Sulphur	ASTM D-5453	ppm			1.0

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26SEPT06

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# **APPENDIX E**

## **AFPET Laboratory Reports**

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DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4971  
Date Sampled: 07/10/2006

Lab Report No: F-2006LA05966  
Date Reported: 07/21/2006  
Date Received: 07/18/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: S-ISO 124166-7  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.003
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	161
	10% Recovered, °C		205	178
	20% Recovered, °C		REPORT	185
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	243
	EP, °C		300	254
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.7
D93	Flash Point, °C	38		56
D5972	Freezing Point, °C		-47	-51
D445	Viscosity @ -20°C, cSt		8.0	4.8
D4809	Heat of Combustion, BTU/lb	18400		18841
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	1
D381	Existent Gum, mg/100mL		7.0	0.2
D5452	Particulate Matter, mg/L		1.0	0.3
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	335
D4052	API Gravity @ 60°F	37.0	51.0	55.7##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.63
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.2
D3338	Heat of Combustion, BTU/lb	18400		18981

Submitter's Sample No: 06POSF4971

Lab Report No: F-2006LA05966

As of : 07/21/2006 14:52:14

Page 2

METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS

REMARKS:

Value obtained for D2622 sulfur was less than 0.0001 % mass. Gas chromatography scan is that of a typical F-T fuel with the n-paraffin signal being 25.3% of the total signal.

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Reported By:



CHERYL M. MCCORMICK  
Chemist

Approved By:



MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4972  
Date Sampled: 07/11/2006

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Lab Report No: F-2006LA05965  
Date Reported: 07/21/2006  
Date Received: 07/18/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: S-ISO 124239-1  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	157
	10% Recovered, °C		205	177
	20% Recovered, °C		REPORT	184
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	242
	EP, °C		300	253
	Residue, % vol		1.5	1.1
	Loss, % vol		1.5	0.7
D93	Flash Point, °C	38		52
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.7
D4809	Heat of Combustion, BTU/lb	18400		18913
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	1
D381	Existent Gum, mg/100mL		7.0	0.2
D5452	Particulate Matter, mg/L		1.0	0.2
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	332
D4052	API Gravity @ 60°F	37.0	51.0	55.8##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.61
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.6
D3338	Heat of Combustion, BTU/lb	18400		18982

Submitter's Sample No: 06POSF4972

Lab Report No: F-2006LA05965

As of : 07/21/2006 14:52:36

Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

---

REMARKS:

Value obtained for D2622 sulfur was less than 0.0001 % mass. Gas chromatography scan is that of a typical F-T fuel with the n-paraffin signal being 24.9% of the total signal.

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Reported By:



CHERYL M. MCCORMICK  
Chemist

Approved By:



MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4969  
Date Sampled: 07/12/2006

Lab Report No: F-2006LA05963  
Date Reported: 07/21/2006  
Date Received: 07/18/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: S-ISO 124146-1  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	156
	10% Recovered, °C		205	176
	20% Recovered, °C		REPORT	184
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	242
	EP, °C		300	254
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.6
D93	Flash Point, °C	38		53
D5972	Freezing Point, °C		-47	-49
D445	Viscosity @ -20°C, cSt		8.0	4.6
D4809	Heat of Combustion, BTU/lb	18400		18879
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	0.2
D5452	Particulate Matter, mg/L		1.0	0.4
SPEC\F	Filtration Time, minutes		15	3
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	340
D4052	API Gravity @ 60°F	37.0	51.0	55.7##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.59
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.8
D3338	Heat of Combustion, BTU/lb	18400		18979



Submitter's Sample No: 06POSF4969

Lab Report No: F-2006LA05963

As of : 07/21/2006 13:44:08

Page 2


METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

REMARKS:


Value obtained for D2622 sulfur was less than 0.0001 % mass. Gas chromatography scan is that of a typical F-T fuel with the n-paraffin signal being 27.0% of the total signal.

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Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4970  
Date Sampled: 07/13/2006

Lab Report No: F-2006LA05964  
Date Reported: 07/21/2006  
Date Received: 07/18/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: S-ISO 124169-3  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	155
	10% Recovered, °C		205	175
	20% Recovered, °C		REPORT	184
	50% Recovered, °C		REPORT	210
	90% Recovered, °C		REPORT	244
	EP, °C		300	254
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.7
D93	Flash Point, °C	38		51
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.7
D4809	Heat of Combustion, BTU/lb	18400		18902
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	0.0
D5452	Particulate Matter, mg/L		1.0	0.5
SPEC\F	Filtration Time, minutes		15	3
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	240
D4052	API Gravity @ 60°F	37.0	51.0	55.7##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.60
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.8
D3338	Heat of Combustion, BTU/lb	18400		18980

Submitter's Sample No: 06POSF4970

Lab Report No: F-2006LA05964

As of : 07/21/2006 13:46:29

Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

REMARKS:


Value obtained for D2622 sulfur was 0.0001 % mass. Gas chromatography scan is that of a typical F-T fuel with the n-paraffin signal being 26.6% of the total signal.

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Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4968  
Date Sampled: 07/14/2006

Lab Report No: F-2006LA05962  
Date Reported: 07/21/2006  
Date Received: 07/18/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: S ISO-124136-9  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	162
	10% Recovered, °C		205	182
	20% Recovered, °C		REPORT	187
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	242
	EP, °C		300	253
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.7
D93	Flash Point, °C	38		56
D5972	Freezing Point, °C		-47	-49
D445	Viscosity @ -20°C, cSt		8.0	4.8
D4809	Heat of Combustion, BTU/lb	18400		18914
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	2
D381	Existent Gum, mg/100mL		7.0	0.2
D5452	Particulate Matter, mg/L		1.0	0.5
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	1093##
D4052	API Gravity @ 60°F	37.0	51.0	55.5##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.58
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	10.4
D3338	Heat of Combustion, BTU/lb	18400		18978

Submitter's Sample No: 06POSF4968

Lab Report No: F-2006LA05962

As of : 07/21/2006 13:42:18

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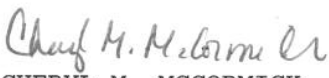
METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

REMARKS:


Value obtained for D2622 sulfur was less than 0.0001 % mass. Gas chromatography scan is that of a typical F-T fuel with the n-paraffin signal being 27.5% of the total signal.

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Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4991  
Date Sampled: 07/24/2006

Lab Report No: F-2006LA06401  
Date Reported: 08/11/2006  
Date Received: 08/08/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin:  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	157
	10% Recovered, °C		205	176
	20% Recovered, °C		REPORT	184
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	244
	EP, °C		300	255
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.9
D93	Flash Point, °C	38		52
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.5
D4809	Heat of Combustion, BTU/lb	18400		18887
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	2
D381	Existent Gum, mg/100mL		7.0	1.0
D5452	Particulate Matter, mg/L		1.0	0.4
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	174
D4052	API Gravity @ 60°F	37.0	51.0	55.8##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.56
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.4
D3338	Heat of Combustion, BTU/lb	18400		18983

Submitter's Sample No: 06POSF4991  
Lab Report No: F-2006LA06401  
As of : 08/11/2006 13:14:15  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	


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REMARKS:


SWRI - ISO #124248-9 & 124146-1-B. Value obtained for D2622 sulfur was less than 0.0002 % mass. Gas chromatography scan appears typical for an F-T fuel with the n-paraffin signal being 26.6% of the total signal.

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Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4988  
Date Sampled: 07/25/2006

Lab Report No: F-2006LA06398  
Date Reported: 08/11/2006  
Date Received: 08/08/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin:  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	155
	10% Recovered, °C		205	174
	20% Recovered, °C		REPORT	183
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	244
	EP, °C		300	256
	Residue, % vol		1.5	1.0
	Loss, % vol		1.5	0.7
D93	Flash Point, °C	38		51
D5972	Freezing Point, °C		-47	-51
D445	Viscosity @ -20°C, cSt		8.0	4.6
D4809	Heat of Combustion, BTU/lb	18400		18851
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	1
D381	Existent Gum, mg/100mL		7.0	0.8
D5452	Particulate Matter, mg/L		1.0	0.4
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	248
D4052	API Gravity @ 60°F	37.0	51.0	55.8##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.58
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.4
D3338	Heat of Combustion, BTU/lb	18400		18981



Submitter's Sample No: 06POSF4988

Lab Report No: F-2006LA06398

As of : 08/11/2006 13:09:11

Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	


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REMARKS:


Edwards AFB - ISO #134169-3 & 124146-1-B. Value obtained for D2622 total sulfur was less than 0.0002 % mass. Gas chromatography scan appears to be that of an F-T fuel with the n-paraffin signal being 29.3% of the total signal.

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Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4989  
Date Sampled: 07/31/2006

Lab Report No: F-2006LA06399  
Date Reported: 08/11/2006  
Date Received: 08/08/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin:  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.005
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	153
	10% Recovered, °C		205	174
	20% Recovered, °C		REPORT	182
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	245
	EP, °C		300	257
	Residue, % vol		1.5	1.0
	Loss, % vol		1.5	0.8
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.5
D4809	Heat of Combustion, BTU/lb	18400		18852
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	4
D381	Existent Gum, mg/100mL		7.0	1.4
D5452	Particulate Matter, mg/L		1.0	0.4
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	267
D4052	API Gravity @ 60°F	37.0	51.0	55.8##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.56
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.4
D3338	Heat of Combustion, BTU/lb	18400		18982

Submitter's Sample No: 06POSF4989

Lab Report No: F-2006LA06399

As of : 08/11/2006 13:08:49

Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	


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REMARKS:


Edwards AFB - ISO #124169-3-B & 126136-9-B. Value obtained for D2622 sulfur was less than 0.0002 % mass. Gas chromatography scan appears to be that of an F-T fuel with the n-paraffin signal being 26.6% of the total signal.

Copy To: AFTT

Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4990  
Date Sampled: 08/04/2006

Lab Report No: F-2006LA06400  
Date Reported: 08/11/2006  
Date Received: 08/08/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin:  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.005
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	151
	10% Recovered, °C		205	173
	20% Recovered, °C		REPORT	181
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	246
	EP, °C		300	257
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.6
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-49
D445	Viscosity @ -20°C, cSt		8.0	4.5
D4809	Heat of Combustion, BTU/lb	18400		18875
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	2
D381	Existent Gum, mg/100mL		7.0	1.2
D5452	Particulate Matter, mg/L		1.0	0.5
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	314
D4052	API Gravity @ 60°F	37.0	51.0	55.9##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.59
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.3
D3338	Heat of Combustion, BTU/lb	18400		18984

Submitter's Sample No: 06POSF4990

Lab Report No: F-2006LA06400

As of : 08/11/2006 13:11:58

Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	


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REMARKS:


Edwards AFB - ISO #124136-9B, 124166-7B, 124146-1C. Value obtained for D2622 sulfur was less than 0.0002 % mass. Gas chromatography scan appears typical for an F-T fuel with the n-paraffin signal being 29.5% of the total signal.

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Reported By:

  
CHERYL M. MCCORMICK  
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Approved By:

  
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DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4997  
Date Sampled: 08/21/2006

Lab Report No: F-2006LA06748  
Date Reported: 08/28/2006  
Date Received: 08/24/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: ISO# 124136-9C  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.007
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	153
	10% Recovered, °C		205	172
	20% Recovered, °C		REPORT	181
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	247
	EP, °C		300	258
	Residue, % vol		1.5	1.4
	Loss, % vol		1.5	0.8
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-49
D445	Viscosity @ -20°C, cSt		8.0	4.9
D4809	Heat of Combustion, BTU/lb	18400		18845
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	1
D381	Existent Gum, mg/100mL		7.0	0.0
D5452	Particulate Matter, mg/L		1.0	0.3
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	211
D4052	API Gravity @ 60°F	37.0	51.0	55.7##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.58
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	10.3
D3338	Heat of Combustion, BTU/lb	18400		18980

Submitter's Sample No: 06POSF4997  
Lab Report No: F-2006LA06748  
As of : 08/28/2006 14:56:27  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

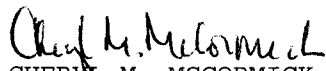
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REMARKS:


Value obtained for D2622 sulfur was 0.0004 % mass. Gas chromatography scan appears to be that of a typical F-T fuel with the n-paraffin signal being 27.7% of the total signal.

Copy To: AFTT

Reported By:

  
CHERYL M. MCCORMICK  
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Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF5002  
Date Sampled: 08/28/2006

Lab Report No: F-2006LA06948  
Date Reported: 09/14/2006  
Date Received: 09/06/2006

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: ISO# 124261-6  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	152
	10% Recovered, °C		205	173
	20% Recovered, °C		REPORT	181
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	247
	EP, °C		300	259
	Residue, % vol		1.5	1.1
	Loss, % vol		1.5	0.6
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.6
D4809	Heat of Combustion, BTU/lb	18400		18910
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	<1
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	0.4
D5452	Particulate Matter, mg/L		1.0	0.4
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	300
D4052	API Gravity @ 60°F	37.0	51.0	55.9##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.64
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	10.2
D3338	Heat of Combustion, BTU/lb	18400		18985



Submitter's Sample No: 06POSF5002  
Lab Report No: F-2006LA06948  
As of : 09/14/2006 09:13:56  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

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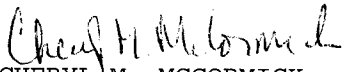
REMARKS:

Value obtained for D2622 sulfur was <0.0002 % mass. Gas chromatography scan appeared to be that of a typical F-T fuel with the n-paraffin signal being 25.4% of the total signal.


Additional Comments from AFTT (E. Alfaro): Eleven gallon sample sent by Syntroleum Corp representative of FTRF shipment #5 to Edwards AFB. Shipment contained 6126 gallons. Results look typical.

Copy To: AFTT

Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF5001  
Date Sampled: 08/28/2006

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Lab Report No: F-2006LA06947  
Date Reported: 09/14/2006  
Date Received: 09/06/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: ISO# 124169-3C  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	153
	10% Recovered, °C		205	172
	20% Recovered, °C		REPORT	181
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	247
	EP, °C		300	258
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	1.1
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-51
D445	Viscosity @ -20°C, cSt		8.0	4.5
D4809	Heat of Combustion, BTU/lb	18400		18909
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	0
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	0.4
D5452	Particulate Matter, mg/L		1.0	0.4
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	243
D4052	API Gravity @ 60°F	37.0	51.0	55.9##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.59
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.7
D3338	Heat of Combustion, BTU/lb	18400		18984

Submitter's Sample No: 06POSF5001  
Lab Report No: F-2006LA06947  
As of : 09/14/2006 10:28:41  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

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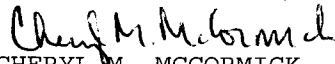
REMARKS:

Value obtained for D2622 sulfur was <0.0002 % mass. Gas chromatography scan appears to be that of a typical F-T fuel with the n-paraffin signal being 24.8% of the total signal.

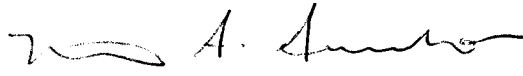
Additional Comments by AFTT (E. Alfaro): Eleven gallon sample sent by Syntroleum Corp. representative of FTRF shipment #6 to Edwards AFB. Shipment contained 6105 gallons. Results look typical.

Copy To: AFTH

Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
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Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4993

Date Sampled: / /

Sample Submitter:

SYNTROLEUM CORPORATION

4322 SOUTH 49TH WEST AVENUE

TULSA, OK 74107-

Lab Report No: F-2006LA06621

Date Reported: 08/25/2006

Date Received: 08/18/2006

Product/Manufacturer/Contractor:

Reason for Submission: Fisher-Tropsch Testing

Product: Aviation Turbine Fuel, Kerosene

Specification: MIL-T-83133 JP-8

Sample Origin: ISO# 124248-9C

Quantity Represented:

NSN:

Contract No:

Batch/Lot:

Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	144
	10% Recovered, °C		205	173
	20% Recovered, °C		REPORT	180
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	246
	EP, °C		300	258
	Residue, % vol		1.5	1.0
	Loss, % vol		1.5	0.8
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.6
D4809	Heat of Combustion, BTU/lb	18400		18755
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	1
D381	Existent Gum, mg/100mL		7.0	0.8
D5452	Particulate Matter, mg/L		1.0	See Below
SPEC\F	Filtration Time, minutes		15	See Below
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	330
D4052	API Gravity @ 60°F	37.0	51.0	55.9##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.58
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.4
D3338	Heat of Combustion, BTU/lb	18400		18984

Submitter's Sample No: 06POSF4993

Lab Report No: F-2006LA06621

As of : 08/25/2006 08:30:15

Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

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REMARKS:

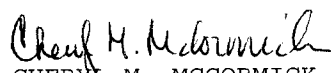
Value obtained for D2622 sulfur was 0.0003 % mass. Gas chromatography scan appears typical for an F-T fuel with the n-paraffin signal being 26.0% of the total signal.

In order to obtain a value particulate matter and filtration time on the five gallon sample can sent, the sample can was shaken and one liter of the sample was poured off and filtered. Particulate matter in the one liter aliquot measured 0.4 mg and the time to filter the one liter was 1 minute.


Amended test report reflecting the assignment of a POSF serial number.

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Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF5035

Date Sampled: 09/12/2006

Sample Submitter:

SYNTROLEUM CORPORATION

4322 SOUTH 49TH WEST AVENUE

TULSA, OK 74107-

Lab Report No: F-2006LA07422

Date Reported: 10/03/2006

Date Received: 09/28/2006

Product/Manufacturer/Contractor:

SYNTROLEUM CORPORATION

4322 SOUTH 49TH WEST AVENUE

TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing

Product: Aviation Turbine Fuel, Kerosene

Specification: MIL-T-83133 JP-8

Sample Origin:

Quantity Represented:

NSN:

Contract No:

Batch/Lot:

Date Manufactured:

METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.005
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	See Below
D4294-03	Total Sulfur, % mass		0.30	
D86	Distillation			
	IBP, °C		REPORT	162
	10% Recovered, °C		205	171
	20% Recovered, °C		REPORT	180
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	246
	EP, °C		300	258
	Residue, % vol		1.5	1.4
	Loss, % vol		1.5	0.7
D93	Flash Point, °C	38		49
D5972	Freezing Point, °C		-47	-49
D445	Viscosity @ -20°C, cSt		8.0	4.7
D4809	Heat of Combustion, BTU/lb	18400		18931
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	0.4
D5452	Particulate Matter, mg/L		1.0	0.2
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	128##
D4052	API Gravity @ 60°F	37.0	51.0	56.0##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.62
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.4
D3338	Heat of Combustion, BTU/lb	18400		18985

Submitter's Sample No: 06POSF5035  
Lab Report No: F-2006LA07422  
As of : 10/03/2006 15:54:22  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

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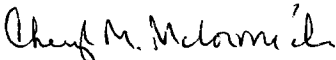
REMARKS:

Value obtained for D2622 sulfur was 0.0002 % mass. Gas chromatography scan appears unusual - isoparaffin cluster indicates an F-T fuel, but a rising background in the scan cannot be explained. The n-paraffin signal was 24.6% of the total signal.

Additional comments from AFTT (E. Alfaro): FTRF sample from Syntroleum Corp representative of shipment #2 to NAVAIR on 15 Sep 06. FTRF ISO container #124146-1C and 124239-1B. Shipment volume: 5400 gallons.

Copy To: AFTT

Reported By:



CHERYL M. MCCORMICK  
Chemist

Approved By:



MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 5018

Date Sampled: / /

Sample Submitter:

AFRL/PRTG

BLDG 490

1790 LOOP ROAD N

WRIGHT PATTERSON AFB, OH 45433-

Lab Report No: F-2006LA06784

Date Reported: 09/07/2006

Date Received: 08/28/2006

Product/Manufacturer/Contractor:

Reason for Submission: Fisher-Tropsch Testing

Product: Aviation Turbine Fuel, Kerosene

Specification: MIL-T-83133 JP-8

Sample Origin:

Quantity Represented:

NSN:

Contract No:

Batch/Lot:

Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	151
	10% Recovered, °C		205	172
	20% Recovered, °C		REPORT	180
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	246
	EP, °C		300	258
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.8
D93	Flash Point, °C	38		49
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.8
D4809	Heat of Combustion, BTU/lb	18400		18879
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	4
D381	Existent Gum, mg/100mL		7.0	2.2
D5452	Particulate Matter, mg/L		1.0	0.2
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	230
D4052	API Gravity @ 60°F	37.0	51.0	55.9##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.55
D445	Viscosity @ -40°C, cSt		REPORT	9.5
D3338	Heat of Combustion, BTU/lb	18400		18983
D976	Cetane Index		REPORT	67



Submitter's Sample No: 5018  
Lab Report No: F-2006LA06784  
As of : 09/07/2006 13:57:00  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

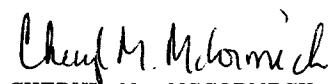
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REMARKS:

For information purposes only. Value obtained for D2622 sulfur was  
0.0003 % mass.

Copy To: AFTH

Reported By:



CHERYL M. MCCORMICK  
Chemist

Approved By:



MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF4998  
Date Sampled: 08/16/2006

Lab Report No: F-2006LA06749  
Date Reported: 08/28/2006  
Date Received: 08/24/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin: ISO# 124146-1C  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.009
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	154
	10% Recovered, °C		205	173
	20% Recovered, °C		REPORT	181
	50% Recovered, °C		REPORT	209
	90% Recovered, °C		REPORT	246
	EP, °C		300	257
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.6
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.9
D4809	Heat of Combustion, BTU/lb	18400		18839
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	1
D381	Existent Gum, mg/100mL		7.0	0.0
D5452	Particulate Matter, mg/L		1.0	0.3
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	355
D4052	API Gravity @ 60°F	37.0	51.0	56.0##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.54
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.9
D445	Viscosity @ 40°C, cSt		REPORT	1.3
D3338	Heat of Combustion, BTU/lb	18400		18987

Submitter's Sample No: 06POSF4998

Lab Report No: F-2006LA06749

As of : 08/28/2006 14:53:55

Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

REMARKS:

Value obtained for D2622 sulfur was 0.0002 % mass. Gas chromatography scan appears to be that of a typical F-T fuel with the n-paraffin signal being 28.4% of the total signal.

Copy To: AFTT

Reported By:



CHERYL M. MCCORMICK  
Chemist

Approved By:



MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 5018

Date Sampled: / /

Sample Submitter:

AFRL/PRTG

BLDG 490

1790 LOOP ROAD N

WRIGHT PATTERSON AFB, OH 45433-

Lab Report No: F-2006LA06784

Date Reported: 09/07/2006

Date Received: 08/28/2006

Product/Manufacturer/Contractor:

Reason for Submission: Fisher-Tropsch Testing

Product: Aviation Turbine Fuel, Kerosene

Specification: MIL-T-83133 JP-8

Sample Origin:

Quantity Represented:

NSN:

Contract No:

Batch/Lot:

Date Manufactured:

METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	151
	10% Recovered, °C		205	172
	20% Recovered, °C		REPORT	180
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	246
	EP, °C		300	258
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	0.8
D93	Flash Point, °C	38		49
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.8
D4809	Heat of Combustion, BTU/lb	18400		18879
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	4
D381	Existent Gum, mg/100mL		7.0	2.2
D5452	Particulate Matter, mg/L		1.0	0.2
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	230
D4052	API Gravity @ 60°F	37.0	51.0	55.9##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.55
D445	Viscosity @ -40°C, cSt		REPORT	9.5
D3338	Heat of Combustion, BTU/lb	18400		18983
D976	Cetane Index		REPORT	67

Submitter's Sample No: 5018  
Lab Report No: F-2006LA06784  
As of : 09/07/2006 13:57:00  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

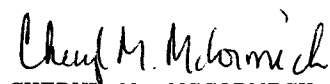
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REMARKS:

For information purposes only. Value obtained for D2622 sulfur was  
0.0003 % mass.

Copy To: AFTH

Reported By:



CHERYL M. MCCORMICK  
Chemist

Approved By:



MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF5032  
Date Sampled: 09/15/2006

Lab Report No: F-2006LA07419  
Date Reported: 10/03/2006  
Date Received: 09/28/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin:  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	154
	10% Recovered, °C		205	173
	20% Recovered, °C		REPORT	181
	50% Recovered, °C		REPORT	208
	90% Recovered, °C		REPORT	245
	EP, °C		300	258
	Residue, % vol		1.5	1.3
	Loss, % vol		1.5	0.3
D93	Flash Point, °C	38		50
D5972	Freezing Point, °C		-47	-51
D445	Viscosity @ -20°C, cSt		8.0	4.5
D4809	Heat of Combustion, BTU/lb	18400		18946
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	0.4
D5452	Particulate Matter, mg/L		1.0	0.2
SPEC\F	Filtration Time, minutes		15	5
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	230
D4052	API Gravity @ 60°F	37.0	51.0	55.9##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.58
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	10.0
D3338	Heat of Combustion, BTU/lb	18400		18983

Submitter's Sample No: 06POSF5032  
Lab Report No: F-2006LA07419  
As of : 10/03/2006 14:36:41  
Page 2

METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS

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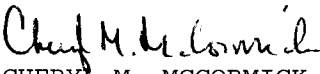
REMARKS:

Value obtained for D2622 sulfur was less than 0.0002 % mass. Gas chromatography scan appears to be that of an F-T fuel with the n-paraffin signal being 22.3% of the total signal.


Additional comments from AFTT (E. Alfaro): FTRF sample from Syntroleum Corp representative of shipment #1 to Wright-Patterson AFB on 18 Sep 06. FTRF ISO container #124166-7C. Shipment volume: 6000 gallons.

Copy To: AFTT

Reported By:

  
CHERYL M. MCCORMICK  
Chemist

Approved By:

  
MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF5034  
Date Sampled: 09/18/2006

Lab Report No: F-2006IA07421  
Date Reported: 10/03/2006  
Date Received: 09/28/2006  
Product/Manufacturer/Contractor:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Sample Submitter:  
SYNTROLEUM CORPORATION  
4322 SOUTH 49TH WEST AVENUE  
TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing  
Product: Aviation Turbine Fuel, Kerosene  
Specification: MIL-T-83133 JP-8  
Sample Origin:  
Quantity Represented:

NSN:  
Contract No:  
Batch/Lot:  
Date Manufactured:

METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.004
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	142
	10% Recovered, °C		205	171
	20% Recovered, °C		REPORT	181
	50% Recovered, °C		REPORT	211
	90% Recovered, °C		REPORT	250
	EP, °C		300	261
	Residue, % vol		1.5	1.3
	Loss, % vol		1.5	0.9
D93	Flash Point, °C	38		48
D5972	Freezing Point, °C		-47	-49
D445	Viscosity @ -20°C, cSt		8.0	4.8
D4809	Heat of Combustion, BTU/lb	18400		18961
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	2
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	0.8
D5452	Particulate Matter, mg/L		1.0	0.3
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	281
D4052	API Gravity @ 60°F	37.0	51.0	55.7##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.60
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	10.1
D3338	Heat of Combustion, BTU/lb	18400		18982



Submitter's Sample No: 06POSF5034  
Lab Report No: F-2006LA07421  
As of : 10/03/2006 15:46:08  
Page 2

METHOD	TEST	LIMITS		LAB RESULTS
		MIN	MAX	

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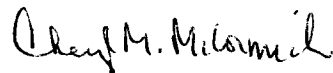
REMARKS:

Value obtained for D2622 sulfur was 0.0009 % mass. Gas chromatography scan appears to be that of a F-T fuel with the n-paraffin signal being 22.5% of the total signal.

Additional comments from AFTT (E. Alfaro): FTRF sample from Syntroleum Corp representative of shipment #2 to Wright-Patterson AFB on 20 Sep 06. FTRF ISO container #124248-9D. Shipment volume: 6026 gallons.

Copy To: AFTH

Reported By:



CHERYL M. MCCORMICK  
Chemist

Approved By:



MIGUEL A. ACEVEDO  
Chief, Aerospace Fuels Laboratory

DEPARTMENT OF THE AIR FORCE  
DET 3, WR-ALC/AFTLA  
2430 C St, Bldg 70 Area B  
Wright-Patterson AFB, OH 45433-7632

LABORATORY TEST REPORT

Submitter's Sample No: 06POSF5033

Date Sampled: 09/19/2006

Sample Submitter:

SYNTHROLEUM CORPORATION

4322 SOUTH 49TH WEST AVENUE

TULSA, OK 74107-

Lab Report No: F-2006LA07420

Date Reported: 10/04/2006

Date Received: 09/28/2006

Product/Manufacturer/Contractor:

SYNTHROLEUM CORPORATION

4322 SOUTH 49TH WEST AVENUE

TULSA, OK 74107-

Reason for Submission: Fisher-Tropsch Testing

Product: Aviation Turbine Fuel, Kerosene

Specification: MIL-T-83133 JP-8

Sample Origin:

Quantity Represented:

NSN:

Contract No:

Batch/Lot:

Date Manufactured:

METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS
SPEC\W	Workmanship		PASS	Pass
D3242	Total Acid Number, mg KOH/g		0.015	0.006
D1319	Aromatics, % vol		25.0	0.0
D3227	Mercaptan Sulfur, % mass		0.002	0.000
D4294-03	Total Sulfur, % mass		0.30	See Below
D86	Distillation			
	IBP, °C		REPORT	151
	10% Recovered, °C		205	172
	20% Recovered, °C		REPORT	182
	50% Recovered, °C		REPORT	210
	90% Recovered, °C		REPORT	249
	EP, °C		300	260
	Residue, % vol		1.5	1.2
	Loss, % vol		1.5	1.1
D93	Flash Point, °C	38		48
D5972	Freezing Point, °C		-47	-50
D445	Viscosity @ -20°C, cSt		8.0	4.9
D4809	Heat of Combustion, BTU/lb	18400		18940
D3343	Hydrogen Content, % mass	13.4		15.4
D1322	Smoke Point, mm	19.0		>40.0
D1840	Naphthalenes, % vol		3.0	Not Req.
D130	Copper Strip Corrosion		1	1a
D3241	Thermal Stability @ 260°C			
	Tube Deposit Rating, Visual		<3	1
	Change in Pressure, mm Hg		25	0
D381	Existent Gum, mg/100mL		7.0	1.0
D5452	Particulate Matter, mg/L		1.0	0.1
SPEC\F	Filtration Time, minutes		15	4
D1094	Water Reaction		1B	1
D5006	FSII (DiEGME), % vol	0.10	0.15	0.00##
D2624	Conductivity, pS/m	150	600	186
D4052	API Gravity @ 60°F	37.0	51.0	55.8##
D5001	Lubricity Test (BOCLE), wear scar mm		REPORT	0.62
GC	Gas Chromatography Scan		REPORT	See Below
D445	Viscosity @ -40°C, cSt		REPORT	9.9
D3338	Heat of Combustion, BTU/lb	18400		19000

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METHOD	TEST	LIMITS		LAB
		MIN	MAX	RESULTS


REMARKS:

Value obtained for D2622 sulfur was less than 0.0002 % mass. Gas chromatography scan appears to be that of a F-T fuel with the n-paraffin signal being 23.8% of the total signal.


Additional comments from AFTT (E. Alfaro): FTRF sample from Syntroleum Corp representative of shipment #3 to Wright-Patterson AFB on 21 Sep 06. FTRF ISO container #124013-0 and 124239-1. Shipment volume: 3527 gallons.

Copy To: AFTT

Reported By:

  
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Approved By:

  
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